US009061763B1

(12) **United States Patent**
Christensen et al.

(10) **Patent No.: US 9,061,763 B1**

(45) **Date of Patent: Jun. 23, 2015**

(54) **ROTORCRAFT WITH INTEGRATED LIGHT PIPE SUPPORT MEMBERS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/461,228**

(22) Filed: **Aug. 15, 2014**

Related U.S. Application Data

(60) Provisional application No. 61/866,530, filed on Aug. 15, 2013.

(51) **Int. Cl.**

B64C 27/00	(2006.01)
B64C 39/02	(2006.01)
A63H 17/28	(2006.01)
A63H 27/00	(2006.01)

(52) **U.S. Cl.**
CPC ***B64C 39/024*** (2013.01); *B64C 2201/027* (2013.01); *A63H 27/12* (2013.01); ***A63H 17/28*** (2013.01)

(58) **Field of Classification Search**
CPC B64C 39/024; B64C 2201/027; B64C 2201/042; B64C 2201/108; B64C 2201/127; B64C 39/028; A63H 27/12; A63H 17/28; A63H 17/32; B64D 47/08; B64D 2203/00
See application file for complete search history.

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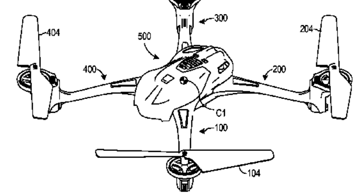
(57) **ABSTRACT**

A radio controlled model rotorcraft implemented with features improving ease of flight and flight performance by increasing structural stability, increasing rotorcraft visibility and orientation awareness through the use of multifunctioning, configurable, and aesthetically pleasing components, while also increasing resistance to damage from crashes through use of impact and vibration absorbing components.

30 Claims, 13 Drawing Sheets



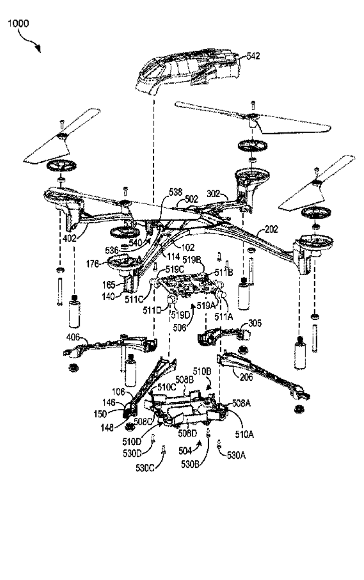


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FIG. 1

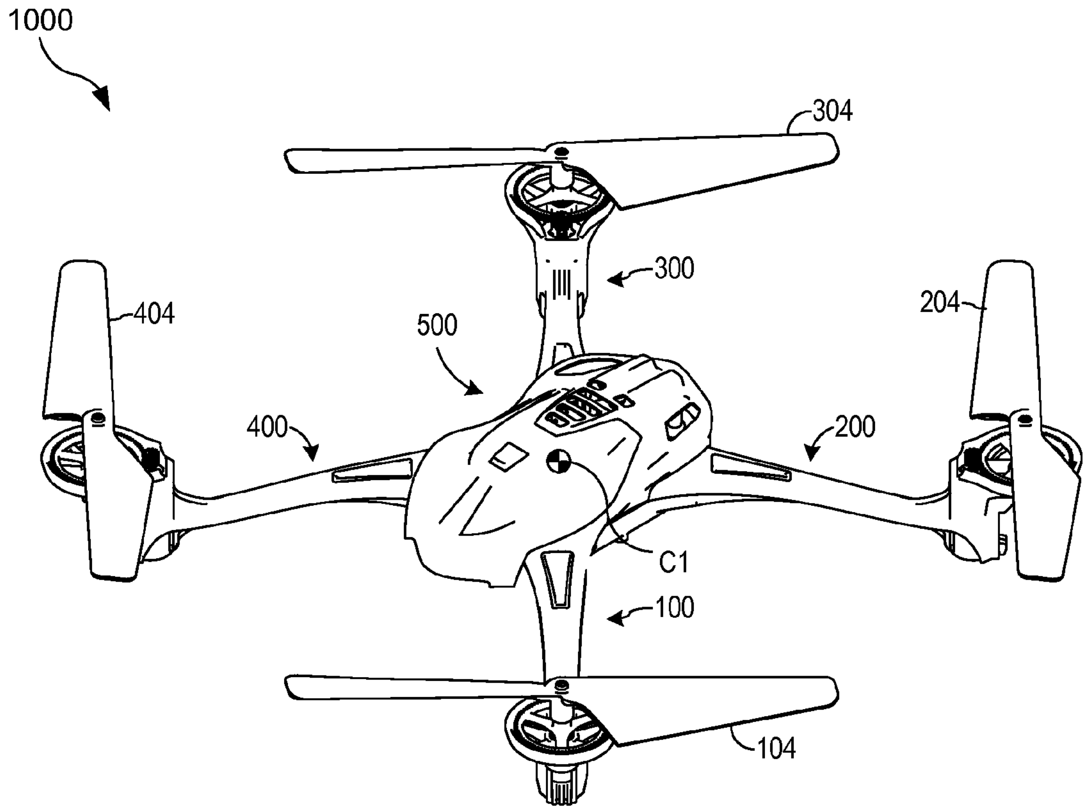
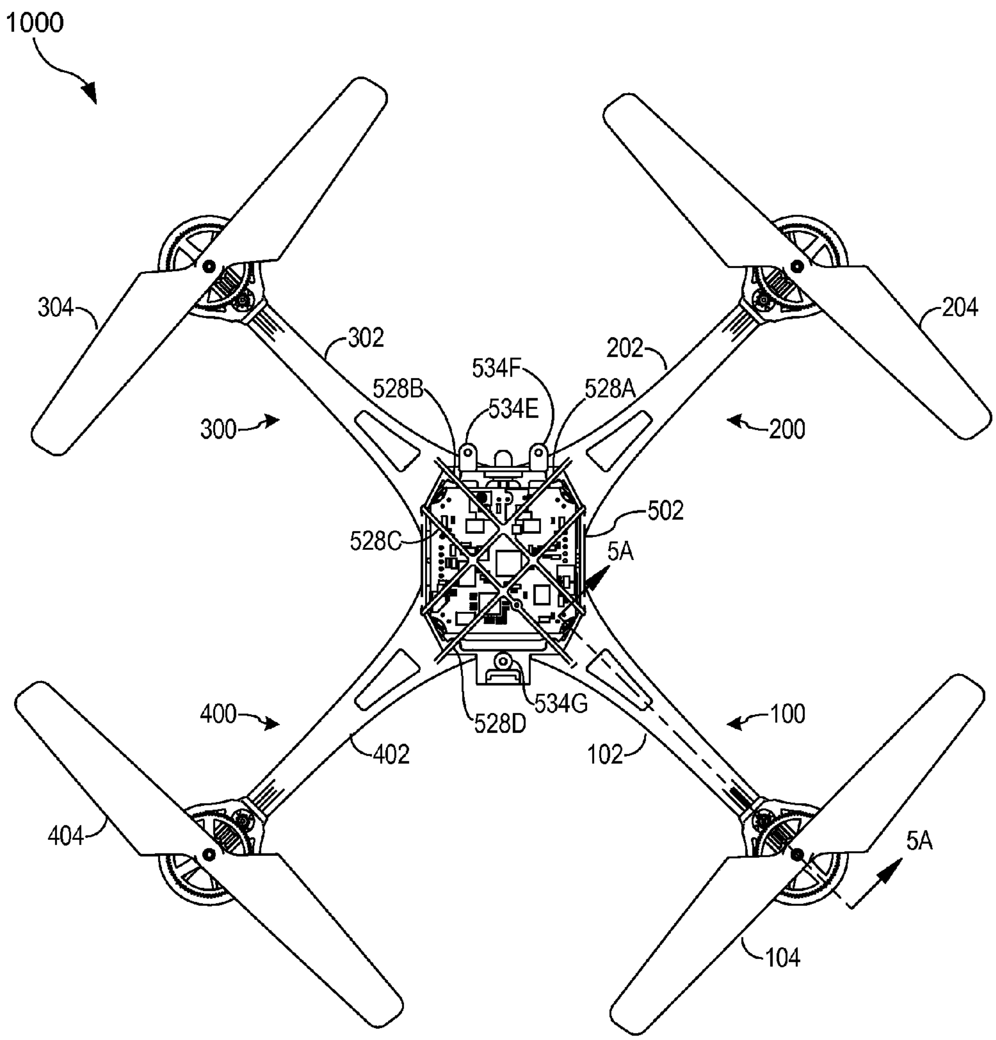


FIG. 2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304
302
202
204
534F
528B
534E
528A
300
200
502
528C
5A
400
534G
528D
100
402
102
404
5A
104

FIG. 3

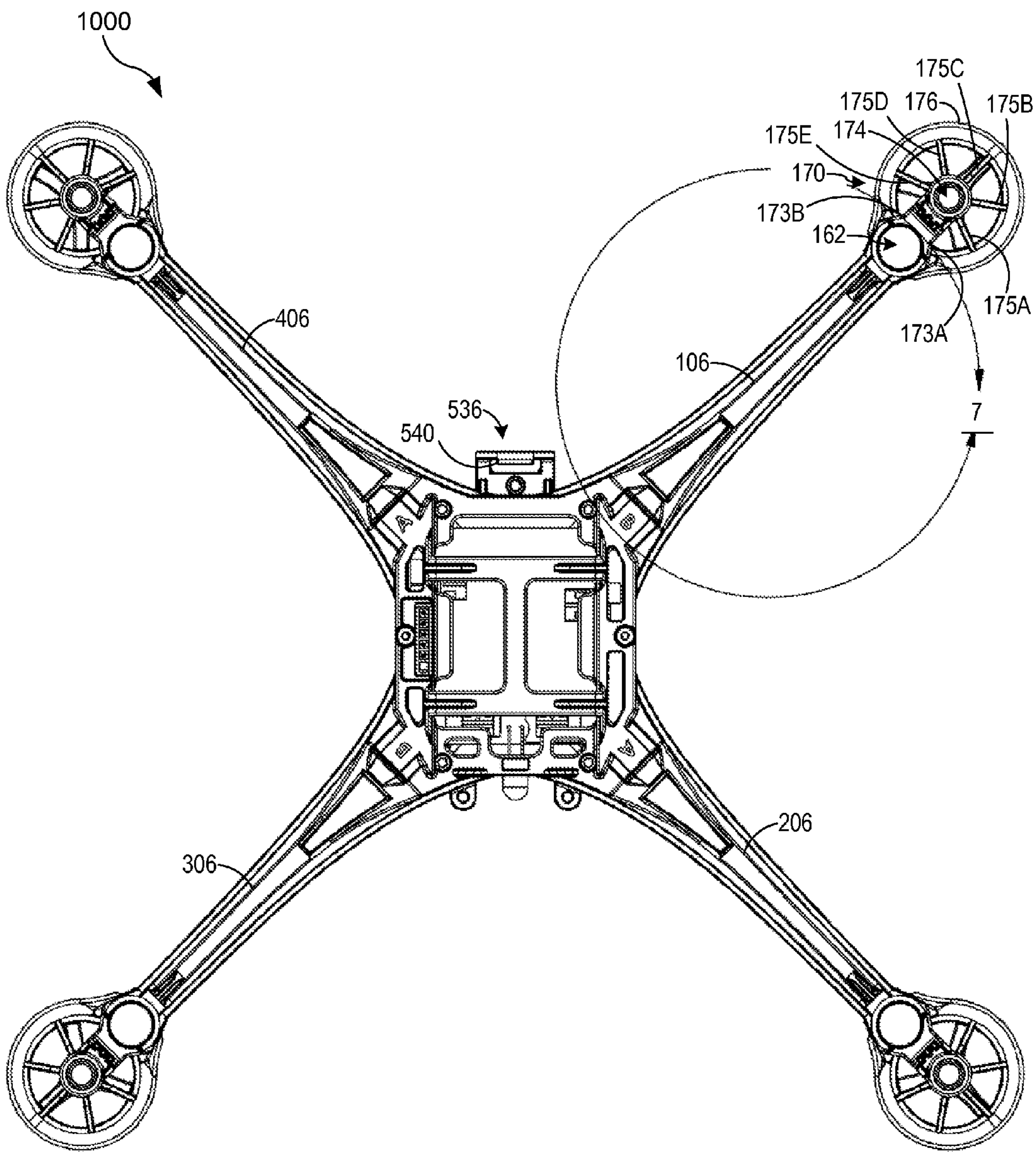
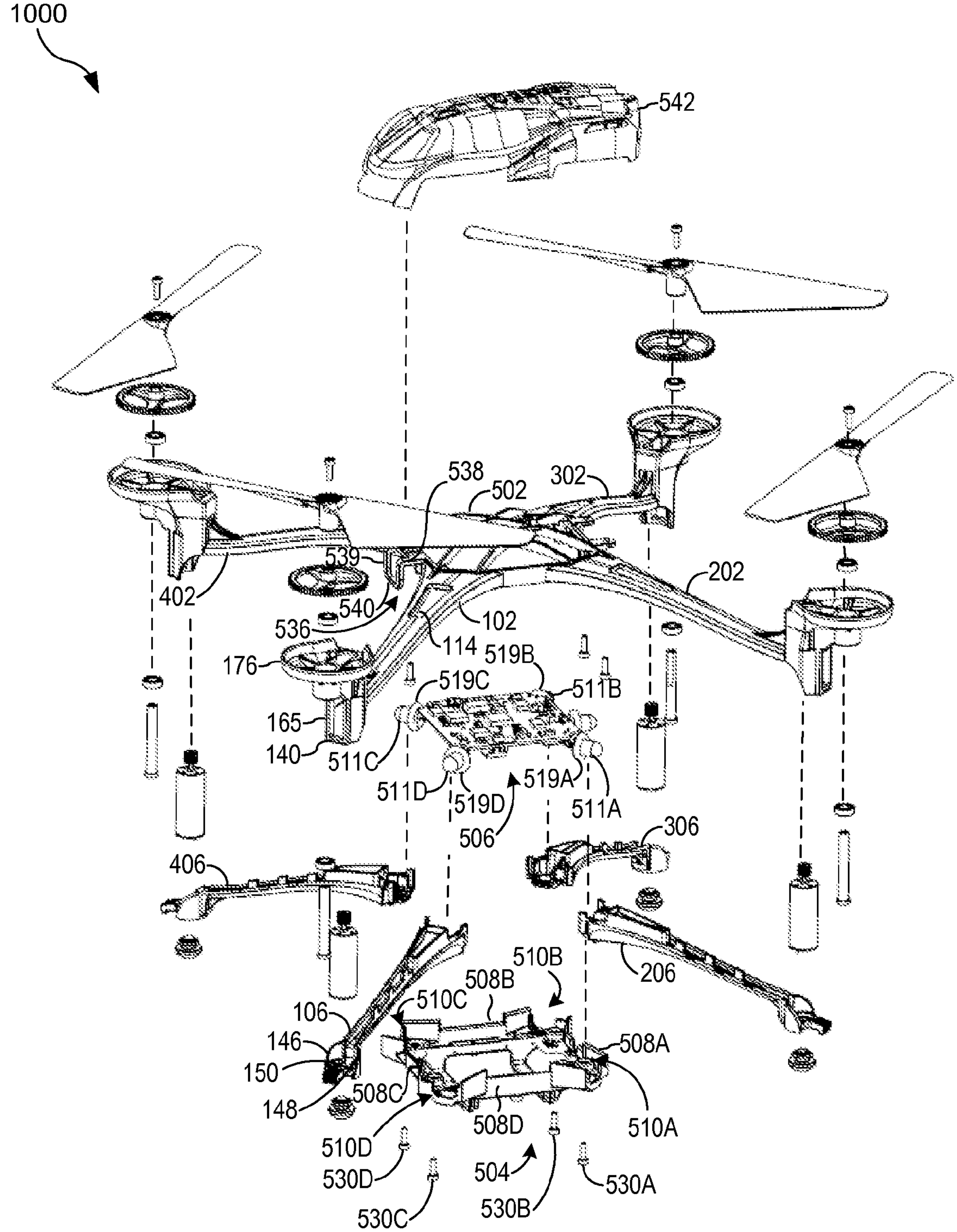

1000
175C
175D
176
175B
175E
174
170
173B
162
175A
173A
406
106
536
540
7
306
206

FIG. 4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542
538
502
302
539
402
540
536
102
202
114
176
519B
519C
511B
165
140
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511D
519D
519A
511A
506
306
406
206
510B
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504
530A
530C
530B

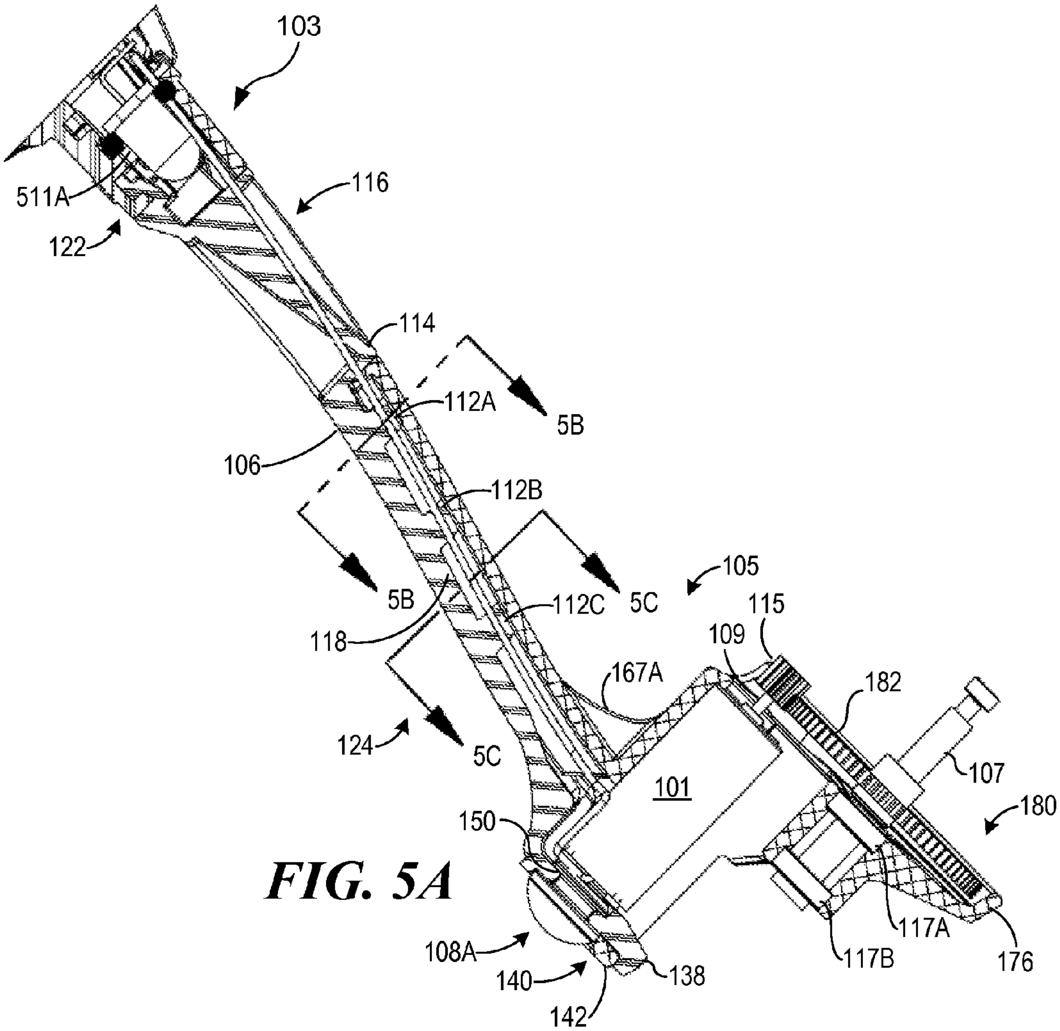


FIG. 5A

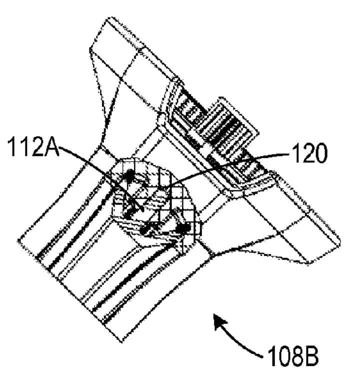


FIG. 5B

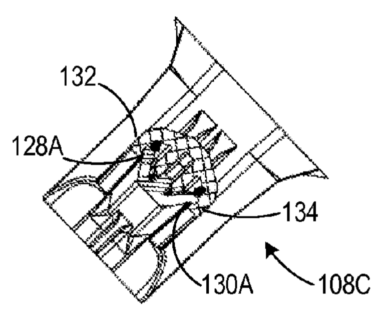


FIG. 5C

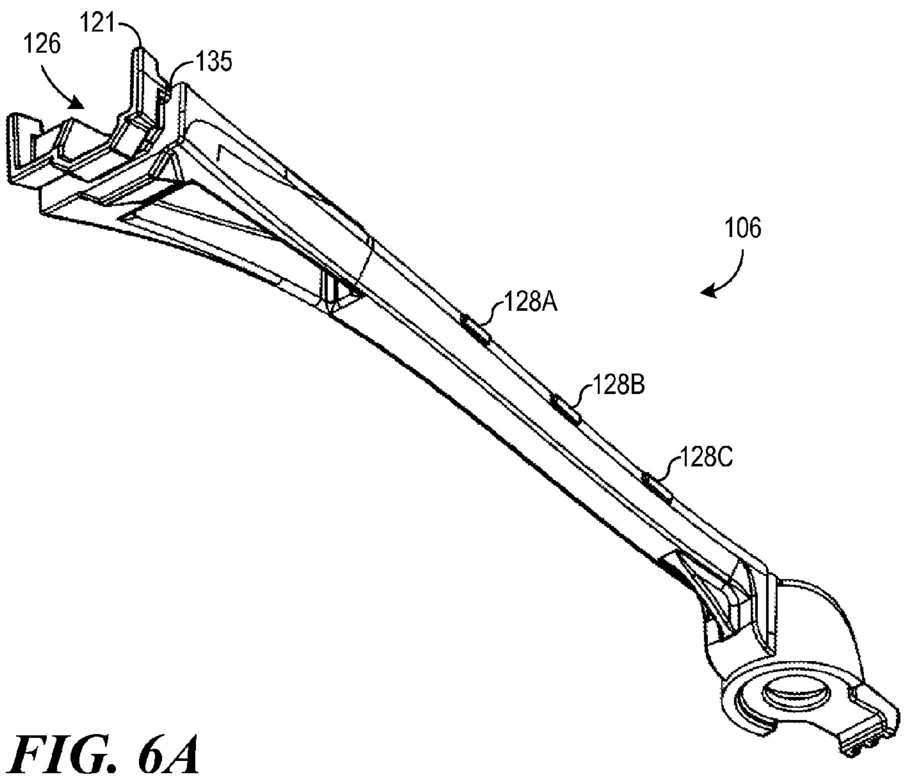

121
126
135
106
128A
128B
128C

FIG. 6A

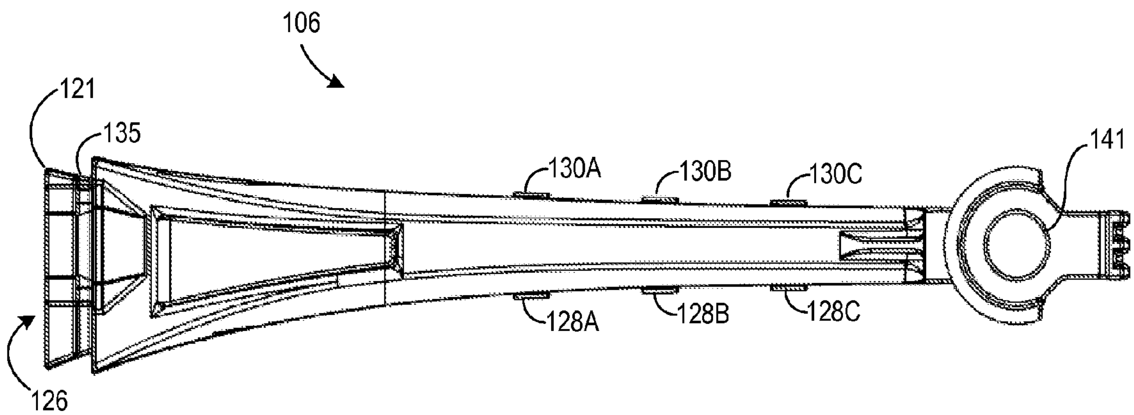

106
121
135
130A
130B
130C
141
128A
128B
128C
126

FIG. 6B

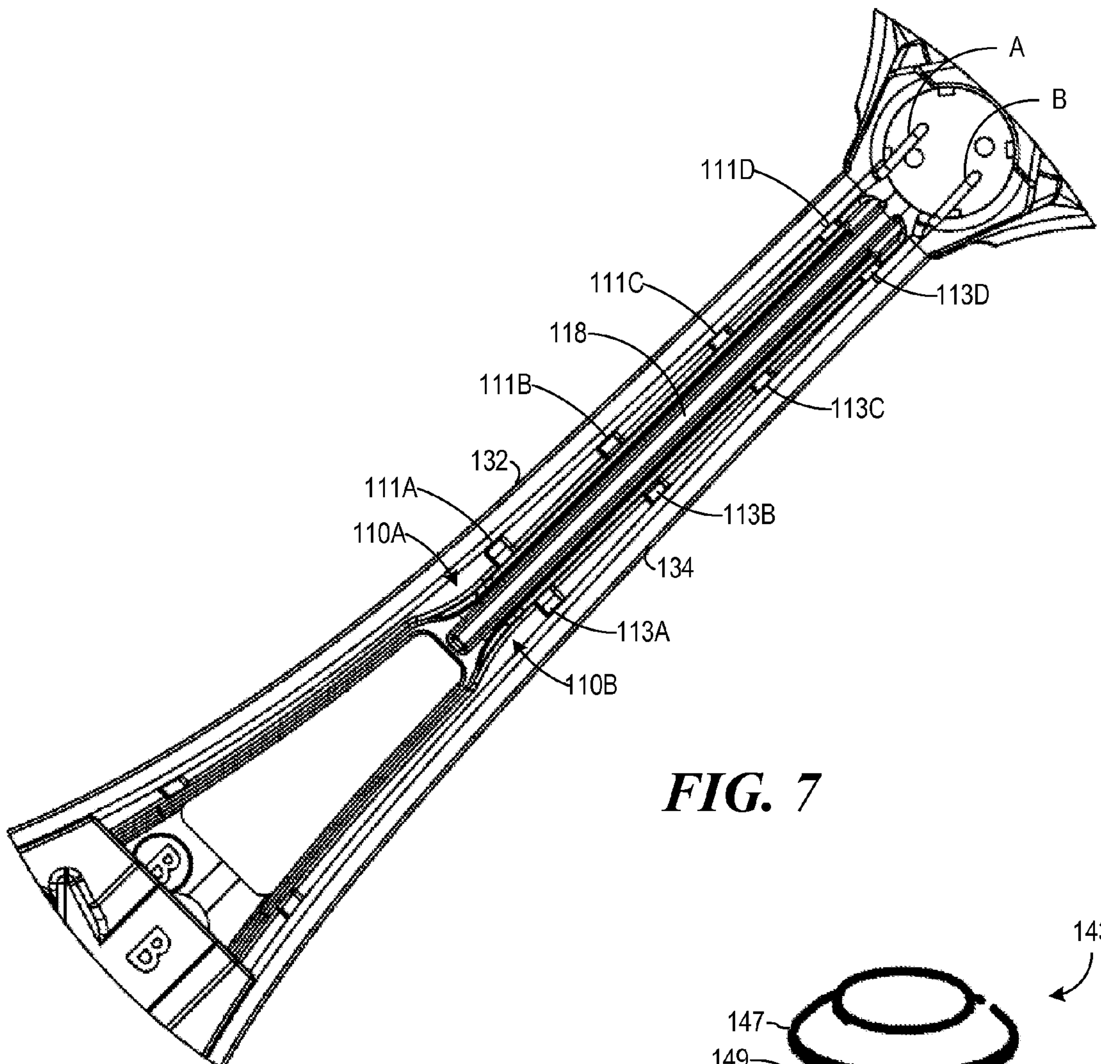

A
B
111D
111C
113D
118
111B
113C
132
111A
113B
110A
134
113A
110B

FIG. 7

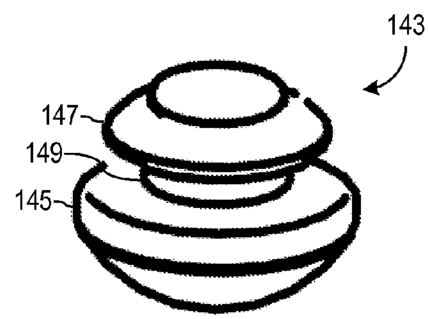

143
147
149
145

FIG. 8

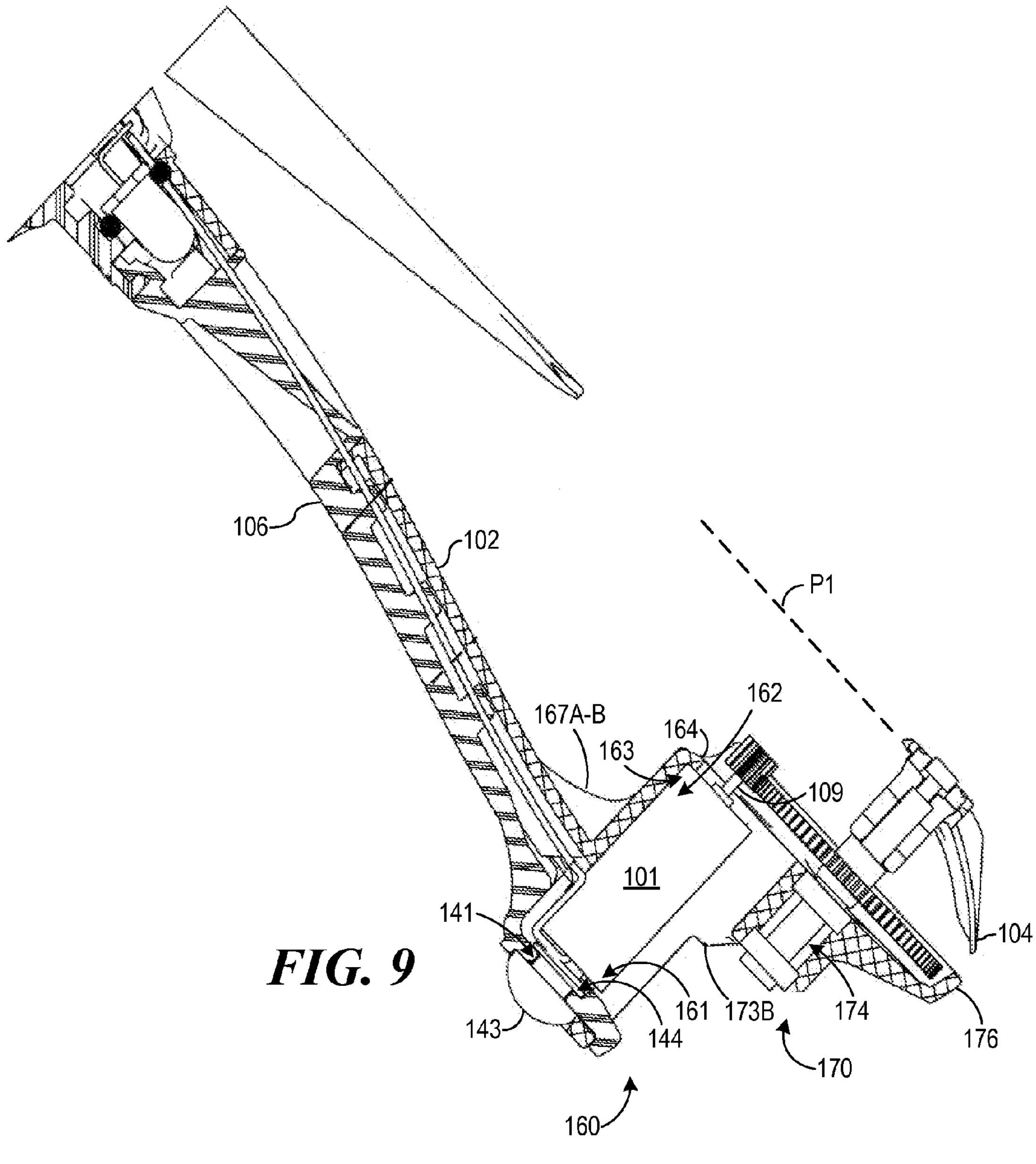
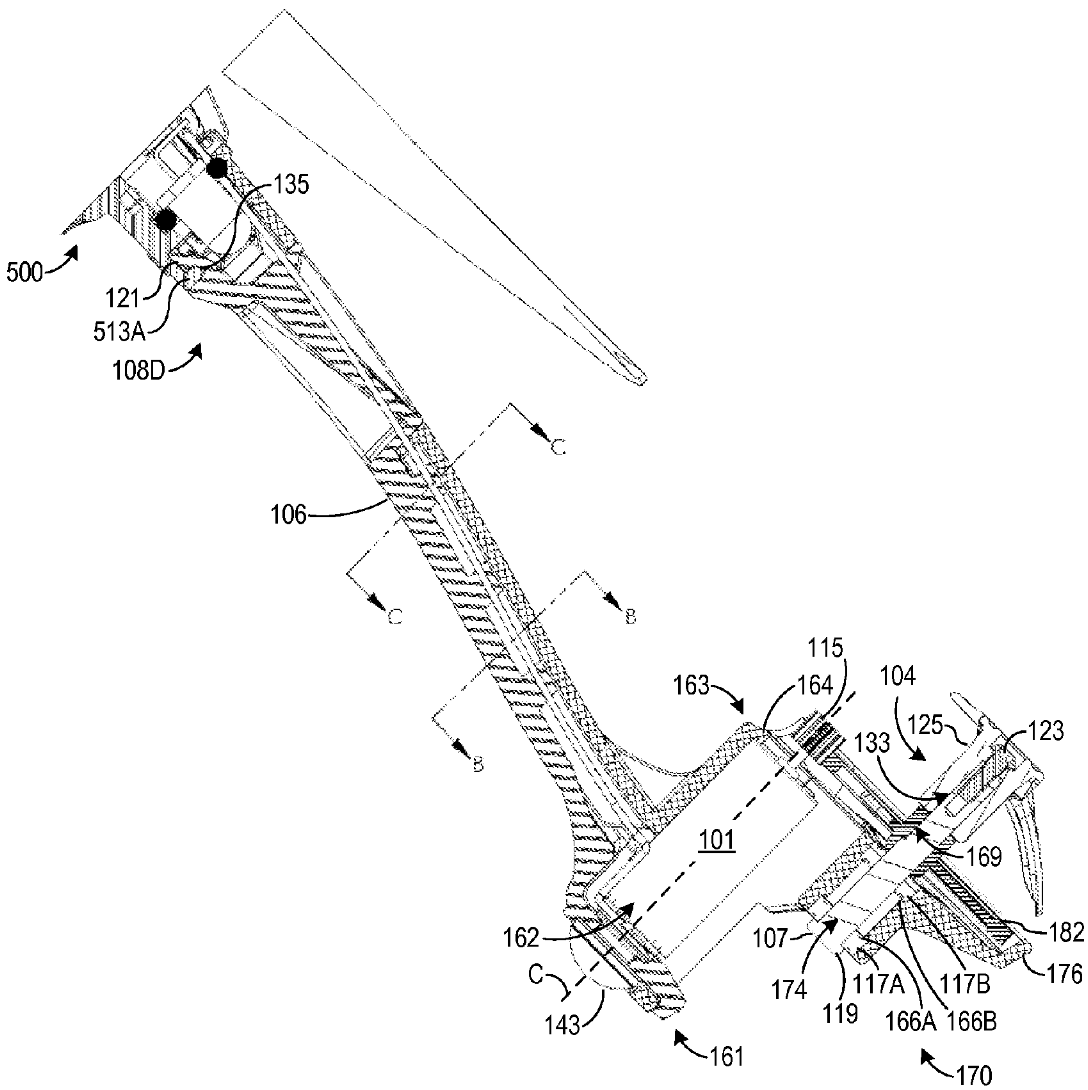

106
102
P1
167A-B
162
164
163
109
101
141
104
161
173B
174
176
143
144
170
160

FIG. 9



500
135
121
513A
108D
C
106
C
B
B
115
164
163
104
125
123
133
101
169
162
107
182
C
174
117A
117B
176
143
119
166A
166B
161
170

FIG. 10

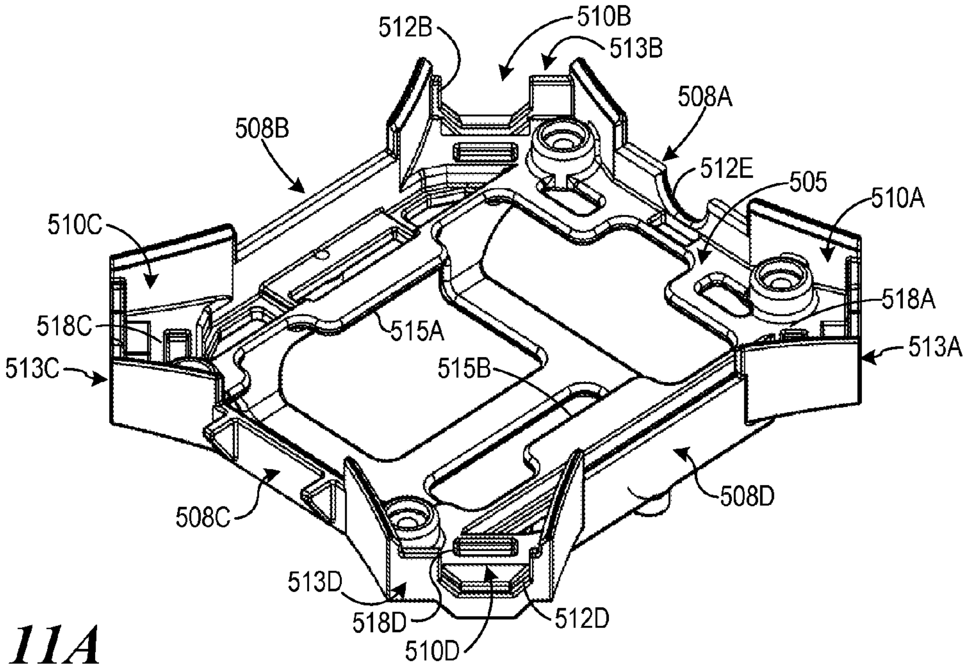


FIG. 11A

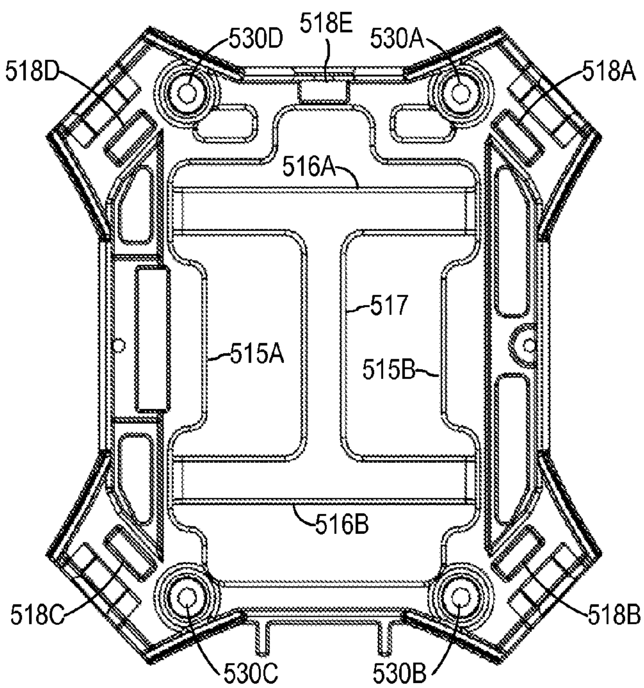


FIG. 11B

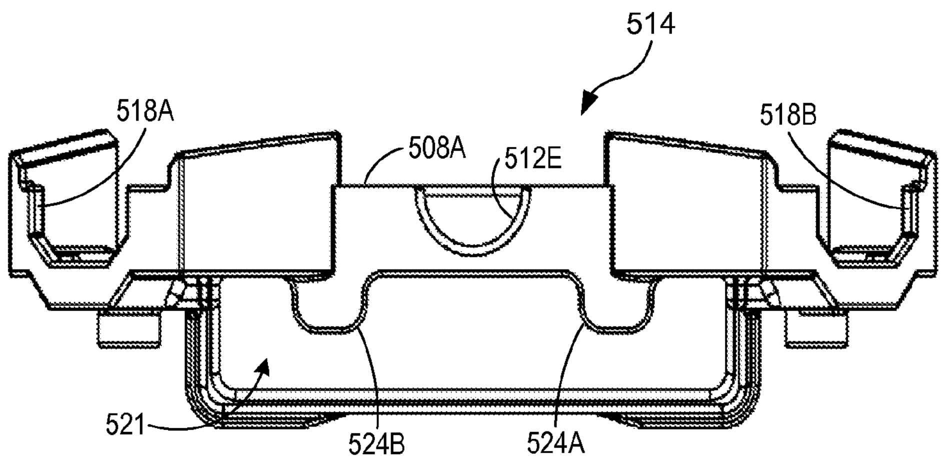


FIG. 11C

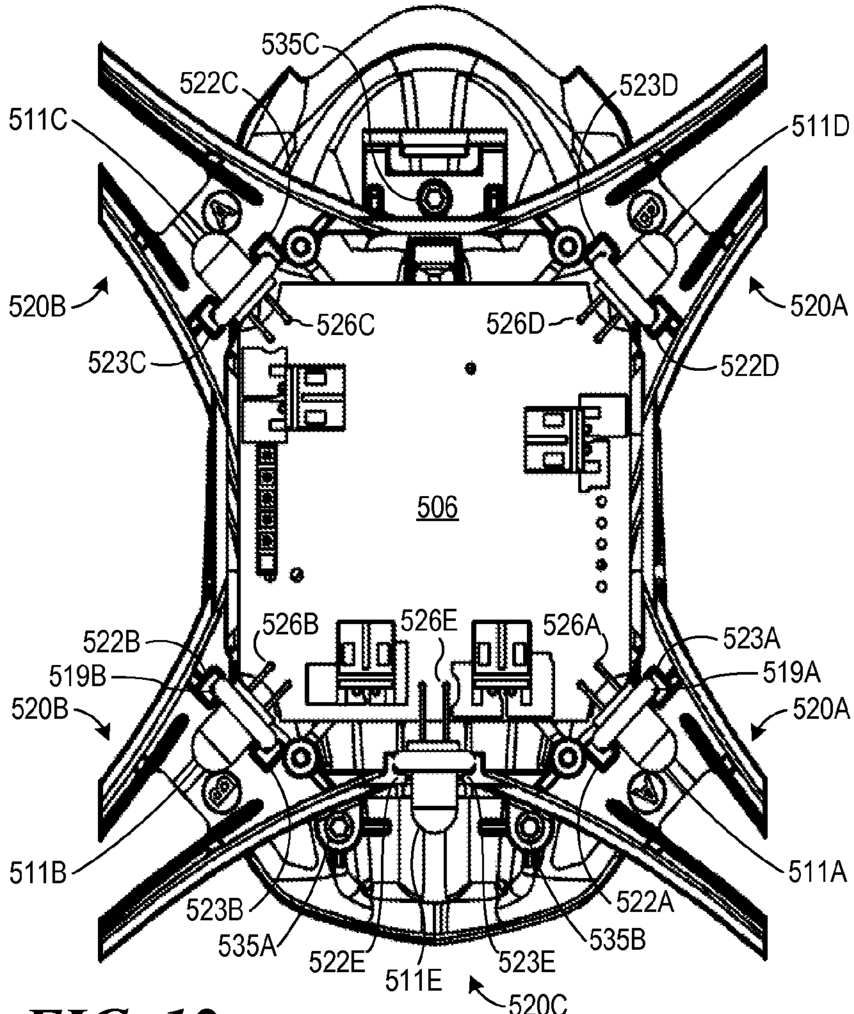


FIG. 12

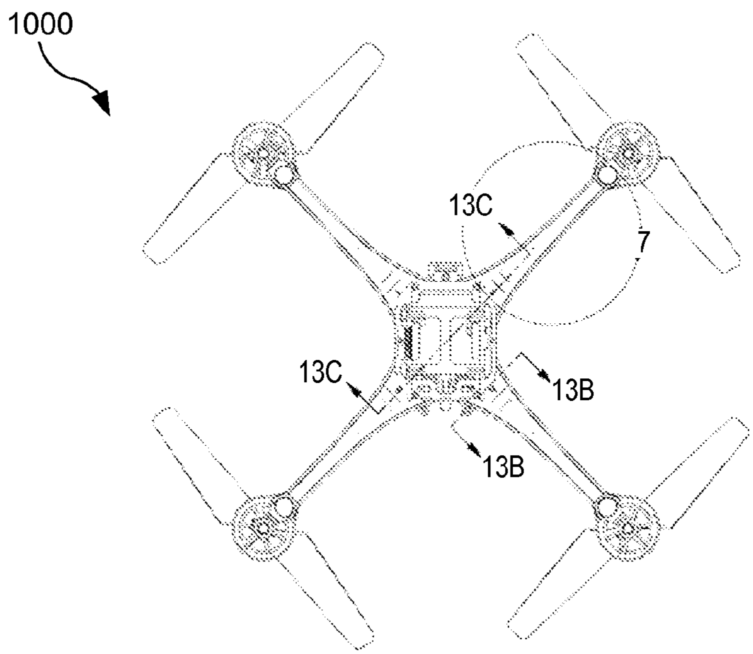


FIG. 13A

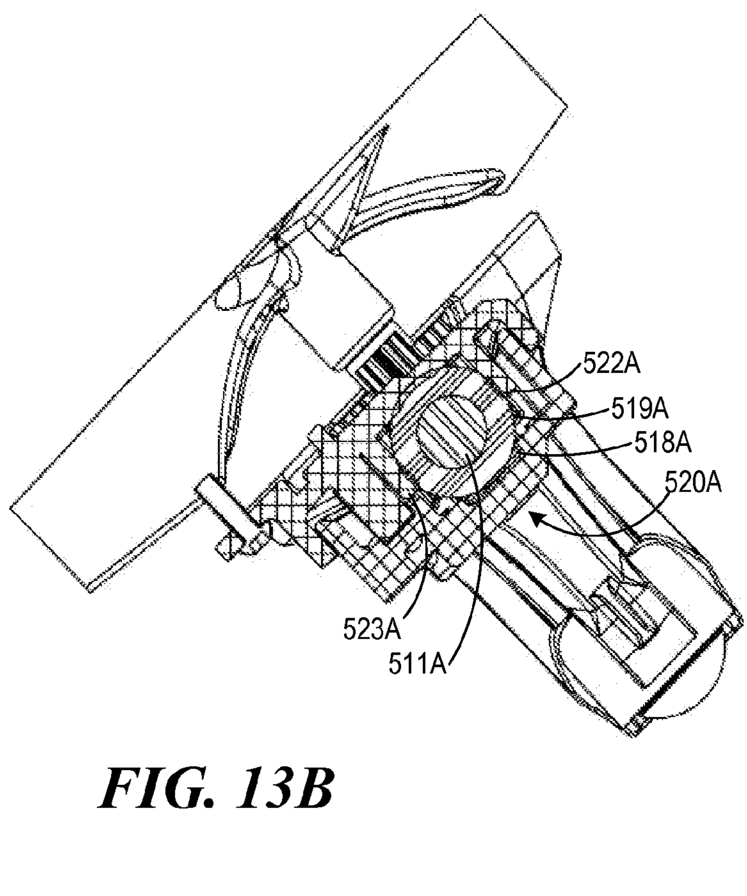


FIG. 13B

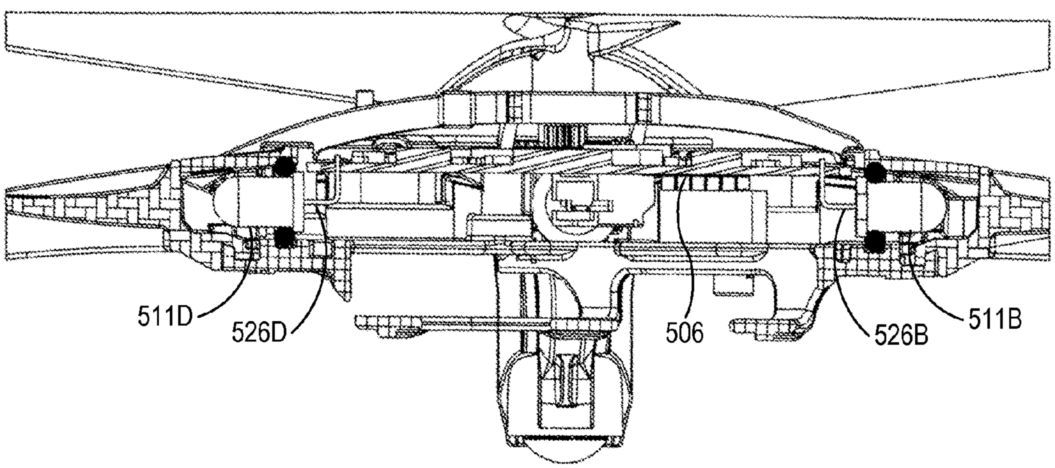


FIG. 13C

ROTORCRAFT WITH INTEGRATED LIGHT PIPE SUPPORT MEMBERS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application relates to, and claims the benefit of the filing date of, U.S. provisional patent application Ser. No. 61/866,530 entitled QUADCOPTER WITH INTEGRATED LIGHT PIPE SUPPORT MEMBERS, filed Aug. 15, 2013, the entire contents of which are incorporated herein by reference for all purposes.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to radio controlled model rotorcrafts, and, more particularly, to means and methods of assembling and retaining components of radio controlled model rotorcraft while enhancing aesthetically pleasing aspects of a rotorcraft.

2. Description of the Related Art

Radio controlled model rotorcrafts are propeller driven remote controlled vehicles configured for flight. Some important design considerations of particular importance in regard to radio controlled model rotorcrafts are flight performance and stability, ease of control by the user, durability, aesthetics, and cost. Several characteristics inherent to radio controlled model rotorcraft operation and appearance add to the difficulty in adequately addressing these design considerations. This is especially true as the number of propellers utilized by the radio controlled model rotorcraft is increased.

Radio controlled model rotorcraft are difficult to operate for several reasons. For one, they are configured to move in three dimensions as opposed to two. Additionally, radio controlled model rotorcraft are capable of reaching incredible speeds during flight, such as when descending from high altitude, reducing the response time for a user to correct course to avoid a crash.

Users may also have difficulty discerning the orientation of the radio controlled model rotorcraft during flight, especially while performing aerial tricks or when operating a rotorcraft that has several propellers, causing the radio controlled model rotorcraft to have a similar appearance from all sides. Confusion as to the orientation of the radio controlled model rotorcraft during flight greatly increases the likelihood of a loss of control by the user and a subsequent crash.

Stable flight requires the radio controlled model rotorcraft body be sufficiently stiff to resist deflection and twisting during flight, in particular, during acceleration. Increasing stiffness generally involves using more material and increasing the overall weight of the rotorcraft. Durability may be enhanced through the use of tougher materials and the addition of protective components to sufficiently insulate sensitive parts from vibration and impact, adding weight.

For flying vehicles weight increases are undesirable, however, since weight increases degrade performance. Further, weight increase may result in increased cost if higher power or additional thrust-generating components are used to compensate for the additional weight.

A need exists for a radio controlled model rotorcraft implemented with design features that simultaneously promote flight performance and stability, ease of control by the user, and durability without incurring cost or weight penalties, and while also incorporating desirable aesthetic attributes.

SUMMARY

Provided is an radio controlled model rotorcraft implemented with features improving ease of flight and flight performance by increasing structural stability, increasing rotorcraft visibility and orientation awareness through the use of multifunctioning, configurable, and aesthetically pleasing components, while also increasing resistance to damage from crashes through use of impact and vibration absorbing components.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following Detailed Description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a perspective view of a quadcopter rotorcraft;

FIG. **2** is a top view of a quadcopter rotorcraft with a pod cover removed for clarity;

FIG. **3** is a bottom view of a quadcopter rotorcraft;

FIG. **4** is an exploded view of a quadcopter rotorcraft;

FIG. **5**A is a first cross-sectional view of a rotor assembly of a quadcopter rotorcraft taken along line **5**A-**5**A shown in FIG. **2**;

FIG. **5**B is a cross-sectional view of a second fastener assembly taken along line **5**B-**5**B shown in FIG. **5**A;

FIG. **5**C is a cross-sectional view of a third fastener assembly taken along line **5**C-**5**C shown in FIG. **5**B;

FIGS. **6**A and **6**B are a perspective and a bottom view, respectively, of a support member;

FIG. **7** is a bottom view of a first arm showing wire channels;

FIG. **8** is a perspective view of a foot;

FIG. **9** is second cross-sectional view of a rotor assembly of a quadcopter rotorcraft taken along line **5**A-**5**A shown in FIG. **2**;

FIG. **10** is a third cross-sectional view of a rotor assembly of a quadcopter rotorcraft taken along line **5**A-**5**A shown in FIG. **2**, wherein the line **5**A-**5**A is taken through a torque transfer assembly;

FIGS. **11**A, B, and C are perspective, top, and rear views, respectively, of a base of a quadcopter rotorcraft;

FIG. **12** is a bottom view of a center pod assembly with a base removed for clarity;

FIG. **13**A is a bottom view of a quadcopter rotorcraft; FIG. **13**B is a cross-sectional view taken along line **13**B-**13**B, the view showing a locator recess; and

FIG. **13**C is a cross-sectional view taken along line **13**C-**13**C, the view showing a printed circuit board assembly (PCBA) mounted within a housing formed by a cover and base of a quadcopter rotorcraft.

DETAILED DESCRIPTION

In the following discussion, numerous specific details are set forth to provide a thorough understanding of the present invention. However, those skilled in the art will appreciate that the present invention may be practiced without such specific details. In other instances, well-known elements have been illustrated in schematic or block diagram form in order not to obscure the present invention in unnecessary detail. Additionally, and for the most part, details concerning well-known features and elements have been omitted inasmuch as such details are not considered necessary to obtain a complete understanding of the present invention, and are considered to be within the understanding of persons of ordinary skill in the relevant art. Additional details are shown in the Appendix attached hereto and incorporated by reference for all purposes.

Referring first to FIG. **1**, a particular embodiment of a radio controlled model rotorcraft, a rotorcraft **1000**, is shown. According to the embodiment shown, the rotorcraft **1000** may comprise four rotor assemblies: a first rotor assembly **100**; a second rotor assembly **200**; a third rotor assembly **300**; and, a fourth rotor assembly **400**. The rotorcraft **1000** may further comprise a center pod assembly **500**.

Each of the first rotor assembly **100**, the second rotor assembly **200**, the third rotor assembly **300**, and the fourth rotor assembly **400** may be implemented with a first propeller **104**, a second propeller **204**, a third propeller **304**, and a fourth propeller **404**, respectively. A rotorcraft provided with four propellers, such as the rotorcraft **1000** shown and described herein, may be referred to as a quadcopter. Airborne motion of the rotorcraft **1000** may be controlled by rotation of the propellers **104**, **204**, **304**, and **404** and by adjustment of the angular velocities of each propeller by known methods to provide adjustment of thrust and torque to support stable flight of the rotorcraft **1000**.

Each of the rotor assemblies **100**, **200**, **300**, and **400** may couple to the center pod assembly **500** at the inboard end of the rotor assembly **100**, **200**, **300**, and **400** and may extend, along its length, away from the center pod assembly **500**. The rotor assemblies **100**, **200**, **300**, and **400** may rigidly couple the propellers **104**, **204**, **304**, and **404** to the center pod assembly **500**, fixing the position and orientation of each respective propeller **104**, **204**, **304**, and **404** relative to each other and to the center of mass, C**1**, of the rotorcraft **1000**.

Referring to the embodiment shown in FIGS. **1** and **2**, the propellers **104**, **204**, **304**, and **404** may be arranged in a substantially rectangular configuration about the center of mass C**1**, which may be within the center pod assembly **500**. In a particular embodiment, for example, the distance between the axis of rotation of opposing propellers may be about 23.5 centimeters (cm.) (i.e. between propellers **104** and **304**), while the distance between the axis of rotation of adjacent propellers may be about 16.6 cm. (i.e. between propellers **104** and **204**). In an embodiment, the propellers **104**, **204**, **304**, and **404** may be positioned at a substantially equal distances from the center of mass C**1**.

In alternative embodiments, a radio controlled model rotorcraft may be provided with more, fewer, or additional components than those shown in the particular embodiment, the rotorcraft **1000**, described herein. Additionally, in alternative embodiments, a radio controlled model rotorcraft may have a different component arrangement than that shown in the particular embodiment, the rotorcraft **1000**, described herein. Specifically, alternative embodiments may include more or fewer rotor assemblies that may be positioned in a substantially triangular or circular configuration about the rotorcraft center of mass. Additionally, in an embodiment, the rotorcraft center of mass may be located at a point external to the center pod assembly **500**.

The components of the first rotor assembly **100** of a particular radio controlled model rotorcraft embodiment, the rotorcraft **1000**, are described herein. The components of the rotor assemblies **200**, **300**, and **400** may have substantially similar construction and features as the corresponding components of the first rotor assembly **100**. Further, the components of the rotor assemblies **200**, **300**, and **400** may perform substantially the same functions as the corresponding components of the first rotor assembly **100**. The convention of describing components of only the first rotor assembly **100** is adopted for the purpose of avoiding unnecessary and repetitive language, only, and shall not foreclose from the scope of this disclosure a wide range of variations, modifications, changes and substitutions that would be understood by those skilled in the art as expressly, or implicitly, disclosed here.

Referring to FIGS. **2**-**10**, the first rotor assembly **100** may include a first arm **102**, a first propeller **104**, a first support member **106**, and fastener assemblies **108**A-D In alternative embodiments, additional, fewer, or different components than those shown may be provided.

In an embodiment, the first arm **102** may operatively couple the first rotor assembly **100** to the center pod assembly **500**, as shown in FIG. **2**. Referring to FIGS. **5**A and **7**, the first arm **102** may include an inboard end **103**, an outboard end **105**, wire channels **110**, a cut through portion **114**, and a plurality of coupling members. In a particular embodiment, the first arm **102** may be provided with additional, fewer, or different components.

The first arm **102** may be comprised of a single piece of rigid or semi-rigid material. For example, in a particular embodiment, the first arm **102** may be made from nylon or other similar material. It will be understood by persons of ordinary skill in the art that the first arm **102** may alternatively be made from any other suitable material (e.g. plastics, metals, wood, and composites) based on the requirements for flight of the particular radio controlled model rotorcraft embodiment and other structural, aesthetic, and cost factors.

As shown in FIGS. **4** and **5**, in an embodiment, the first arm **102** may couple to, or, alternatively, be integrally formed with the center pod assembly **500** at the inboard end **103**. The first arm **102** may extend along its length in a direction away from the center pod assembly **500**. As viewed from the side, the first arm **102** may have a downwardly sloping arced profile, whereby the outboard end **105** is disposed below the inboard end **103**. Alternatively, the first arm **102** may have a profile that is substantially linear, dog-legged, or the like, or may have a profile with multiple bends or curves.

As shown in FIGS. **1**, **4**, **5**B, and **5**C, the first arm **102** may have a curved, substantially "C" shaped, outer cross sectional shape, oriented with the apex of the curve facing upward. In an embodiment, and as shown in FIGS. **5**A and **5**B, within the inner portion of the curved cross section the first arm **102** may be provided with an interlocking slot **120**.

The interlocking slot **120** may have an open end facing substantially downward. The interlocking slot **120** may abut the inner portion of the curve defining the outer cross sectional shape of the arm **102** substantially at the apex of the curve. The interlocking slot **120** may be formed from two substantially parallel flanges extending inward from the inner surface of the first arm **102** curved outer cross section. The interlocking slot **120** may extend a distance along the length of the first arm **102** from the outboard end **105** and terminating at the cut through portion **114**. The interlocking slot may function as a fastening feature, as described below, in reference to fastener assembly **108**B.

Viewing the first arm **102** from above, as shown in FIG. **2**, the first arm **102** may be curved along each side, whereby the first arm **102** may be thinner at the outboard end **105** and wider at the inboard end **103**. In an alternative embodiment, the first arm may have a substantially uniform width along its length, or, may widen along its length such that the outboard end **105** is wider than the inboard end **103**.

Referring to FIG. **7**, the first arm **102** may be provided with wire channels **110**A and **110**B for retaining and routing electrical wires A, B along the length of the first arm **102**. In an embodiment, wires A, B may be routed between rotor assembly **100** components near the outboard end **105** of the first arm **102**, like the first motor **101**, for example, and controls components that may be enclosed within the center pod assembly **500**, like the PCBA **506**, for example, to support powered flight of the rotorcraft **1000**.

Each wire channel **110**A and **110**B may extend along the length of the first arm **102** from the inboard end **103** to the outboard end **105** along the underside of the first arm **102**. The wire channels **110**A and **110**B may be positioned along either side of interlocking slot **120**. In an embodiment, the first arm **102** may have fewer or more wire channels **110** that may extend along only a portion of the length of the first arm **102**, or, alternatively, along substantially the entire length of the first arm **102**.

Each wire channel **110**A, B may have dimensions, such as width w, and may be provided with retaining tabs **111**A-C and **113** A-C, respectively, for holding wires A, B in place and substantially resisting migration of wires within each wire channel **110**A, B. In a particular embodiment, for example, the width, w, of each wire channel **110**A, B may be about 0.65 cm. The retaining tabs **111**, **113** may extend laterally across a portion of the width, w, of the respective wire channels **110** so that the wires A, B may be pushed around the retaining tabs **111**, **113** and into place in the wire channels **110**A, B. Alternatively, the retaining tabs **111**, **113** may extend across substantially the entire width, w, of the wire channels **110**A, B with wires A, B being fed through the gap formed.

In an alternative embodiment, the wire channels **110** A, B may be provided with fewer or more retaining tabs **111**, **113** than shown in FIG. **7**. Further, in an alternative embodiment, the wire channels **110**A, B may be provided with zero retaining tabs **111**, **113**. In such embodiments, the wire channels A, B may be implemented with other retaining devices, such as external clips, ties, and the like. Alternatively, the wire channels **110**A, B may not include any retaining devices or external fasteners.

Referring to FIG. **7**, the first arm **102** may include a cut through portion **114** forming an opening for seeing through a portion of the first arm **102**. In an embodiment, the cut through portion **114** may be disposed along top surface of the first arm **102**, substantially centered about the apex of the outer curved surface of the first arm **102** and extending a distance along the length of the first arm **102**. In the embodiment shown, the cut through portion **114** may have a substantially trapezoidal shaped perimeter.

In alternative embodiments, the first arm **102** may be provided with zero, one, or a plurality of cut through portions **114**. Further, in an alternative embodiment, the cut through portion, or portions, **114** may be positioned at other locations along the outer surface of the first arm **102** and, additionally, may have s different perimeter shape, or shapes. For example, in an embodiment, the first arm may be provided with a plurality of circular cut through portions **114** disposed in an irregular pattern along the length of the outer surface of the first arm **102**.

The first arm **102** may also include a plurality of coupling members comprising components of the fastening assemblies **108**A-D for coupling with, receiving, or partially forming other rotorcraft **1000** components, such as the motor **101**, the first support **106**, the motor receptacle assembly **160**, the propeller shaft receptacle assembly **170**, and the torque transfer assembly **180**. The coupling members of the first arm **102** are described in detail below, and in reference to fastening assemblies **108**A-D.

Turning now to the top-view of the rotorcraft embodiment, the rotorcraft **1000**, shown in FIG. **2**, the first propeller **104** is shown. In a particular embodiment, the first propeller **104** may have two blades and a diameter of 140 millimeters (mm). In alternative embodiments, the propeller **104** may be implemented with a different quantity of blades having a larger or smaller diameter. The first propeller **104** may be rotatably coupled to the outboard end **105** of the first arm **102**, as will be described further subsequently, and in reference to the propeller shaft receptacle assembly **170** and the torque transfer assembly **180**.

In an embodiment, the propellers **104**, **204**, **304**, and **404** may comprise matched pairs of counterclockwise and clockwise rotating propellers to provide a stable spinning configuration in accordance with known methods comprising the prior art. It will be understood by persons of ordinary skill in the art that the number of blades, diameter, pitch, and spinning configuration may be varied to support agility, stability, and efficiency of a rotorcraft, such as the rotorcraft **1000** described herein, in flight.

Turning now to FIGS. **4-10**, several views of the first support member **106** are shown. According to the embodiment shown, the first support member **106** may perform many functions, including: providing configurable and decorative lighting along the length of the first rotor assembly **100** for aiding users in identifying directional orientation of the rotorcraft **1000** during flight; providing structural support to the first arm **102**, thereby increasing the stiffness of the rotor assembly **100** for more stable flight; receiving, coupling, or securing other components to the rotorcraft **1000**.

Importantly, in the context of flying devices such as radio controlled model rotorcrafts, having a single component perform multiple functions, as the first support member **106** may, may allow for incorporation of additional features into the device without incurring a corresponding "mass penalty," resulting in a potentially less costly and more capable device. Additionally, the number of component parts may be reduced, and may provide the benefits of easier assembly and maintenance through a reduction in the number of external fasteners needed, for example, screws, clips, inserts, and the like.

As shown in FIG. **3**, the first support member **106** may couple to the center pod **500** and to the first arm **102**. As shown in FIGS. **4-6**B, in an embodiment, the first support member **106** may include an exposed surface **116**, an inboard end **122**, an outboard end **124**, an indented portion **126**, and a plurality of coupling members comprising components of the fastening assemblies **108**A-D. In alternative embodiments, the first support member may include fewer, additional, or different components.

In an embodiment, the first support member **106** may comprise a piece of semi-rigid or rigid material that may be transparent or semi-transparent and capable of distributing light received from a light source substantially throughout its volume, illuminating the surfaces of the transparent or semi-transparent material. For example, the first support member **106** may be made from an acrylic, polycarbonate, or other like material.

The material may appear substantially clear or, alternatively, may have a color. Coloring may be provided through any known methods, such as through tinting, coating, or other known method comprising the prior art. Further, whether the material appears substantially clear, or has a color, the material may be capable of receiving light of a specific color and emitting light of a different color when illuminated. For example, the first support member **106** may be composed of a substantially clear material having the properties described above and may, when receiving white light illuminate and emit light of another color, perhaps green. In another example, the first support member may have a color, perhaps red, and may illuminate and emit red light upon receiving white light or colored light.

In certain embodiments, the first support member **106** may be made entirely of material having the rigidity and illuminating characteristics described above, so that substantially the entire outer surface of the first support member **106** may be illuminated when light is received by any portion of the support member **106**. Further, in such an embodiment, the first support member **106** may be made from a single piece of material having the properties described above.

In alternative embodiments, the first support member **106** may be composed of two or more materials, with at least one of the materials having the rigidity and illuminating properties described above. In such an embodiment, the portion of the first support member **106** composed of the material capable of being illuminated may be implemented so that it extends from the inboard end **122** along the length of the first support member **106**, and toward the outboard end **124**. Further, in such an embodiment, the portion of the first support member **106** composed of the material capable of being illuminated may extend along substantially the entire length of the first support member **106**.

As shown FIGS. **3**, **6**A, and **6**B, the first support member **106** may couple to the center pod assembly **500** at the inboard end **122** and extend along its length in a direction away from the center pod assembly **500**. Viewed from the side, as shown in FIG. **9**, the first support member **106** may have a downwardly sloping arced profile similar to that of the first arm **102**, whereby the outboard end **124** is disposed below the inboard end **122**. In alternative embodiments, the first support member **106** may have a profile that is substantially linear, dog-legged, or the like, or may have a profile with multiple bends or curves.

Referring to FIG. **5**A, the first support member **106** may be provided with an exposed surface **116**. The exposed surface may extend through the cut-through portion **114** of the first arm **102**, when the first arm **102** and first support member **106** are coupled. The exposed surface **116** may composed of an illuminating material as described above so that a portion of the illuminated first support member **106** may be viewed from above the rotorcraft through opening formed by the cut through portion **114** of the first arm **102**.

As shown in FIGS. **4** and **5**A, the exposed surface **116** may be disposed along the side of the first support member **106** to which the first arm **102** couples, protruding upward from the body of the support arm **106**. The exposed surface **116** may extend a distance along the length of the first support member **106**. The position of exposed **116** may align with the position of the cut through portion **114** of the first arm **102** when the first arm **102** and first support member are coupled.

The exposed surface **116** may be configured to have a perimeter shape substantially coincident with the perimeter shape of the cut through portion **114** of the first arm **102**. In the embodiment shown, the cut through portion **114** may have a substantially trapezoidal shaped perimeter. The exposed surface **116** may fit within the opening in the first arm **102** formed by the cut through portion **114**. Further, the exposed surface **116** may protrude to a height above the surface of the first support member **106** sufficient to substantially “fill” the opening formed in the first arm **102** by the cut through portion **114**.

In alternative embodiments, the quantity, location, perimeter shape, and height of the exposed surface, or surfaces **116**, may vary in accordance with the corresponding features of the cut through portion, or portions **114**, of the first arm **102**, so that the exposed surface **116** may “fill” the opening formed in the first arm **102** by the cut through portion **114**.

Referring to FIGS. **5**A-C, the first support member **106** may have a curved, substantially “C” shaped, outer cross section extending along the portion of its length outboard of the exposed surface **116**. The curved cross sectional shape may be oriented with the apex of the curved surface facing substantially downward and with the “open end” facing upward and toward the first arm **102**. The first support member **106** may have an outer cross section configured to mate to the first arm **102** along the length of each component. The outer cross section size of the first support member **106** may be sized to fit within, and extend into, the downwardly facing open end of the first arm **102** formed by the inner surface of the outer cross section of the first arm **102**.

The first support member **106** may be provided with a ridge **118** extending along a portion of the length of the first support member **106**. The ridge **118** may be disposed along the inner surface formed by the substantially “C” shaped cross section of the first support member **106** and protrude a. The ridge **118** is described further below, in regard to the fastening assembly **108**B.

As shown in FIG. **6**A, the first support member **106** may be provided with an indented portion **126** disposed at the inboard end **122** and extending into the body of the first support member **106** along the length of the first support member **106**. The indented portion **126** may form an open area within the body of the first support member **106** providing clearance for a light source **511** to be partially inserted into when the first support member **106** is coupled to the center pod assembly **500**, as described below. The indented portion **126** may extend into the first support member **106** along the length of the first support member **126** and terminate just inboard of the exposed surface **116**.

Viewed from below, as shown in FIG. **3**, the first support member **106** may have a profile that is curved along each side so that the width of the first support member **106** thins along the length of the first support member **106**, with the first support member **106** wider at the inboard end **122** and thinner at the outboard end **124**. In an alternative embodiment, the first arm may have a substantially uniform width along its length, or, may widen along its length such that the outboard end **124** is wider than the inboard end **122**.

The profile shape of the support member **106** may be substantially similar to the profile shape of the first support member shown in FIG. **2** and described above. The first support member **106** profile width may be sufficiently less than that of the first arm **102** along the length of each component, allowing for the first support member to be slid into and mate with the first arm **102**.

Referring to the embodiment shown in FIGS. **3** and **5**A, the first support member **106** may be removably coupled to the first arm **102**. The first support member **106** may structurally support the first arm **102** against displacement from flexing or twisting that may result from acceleration or impact during operation of the rotorcraft **1000**. The coupled first arm **102** and first support member **106** may exhibit increase stiffness along the length of the rotary assembly **100** and provide for more stable flight of the rotorcraft **1000**. Additionally, the coupled first arm **102** and first support member **106** partially enclose rotary assembly components, such as the motor **101**, for example, and may trap and protect rotorcraft **1000** components, such as the wires A, B routed within wire channels **110**A, B as shown in FIGS. **5**A, B (not labeled).

The rotary assembly **100** may include the fastener assemblies **108**A-C for coupling the first support member **106** to the first arm **102**. In alternative embodiments, the first support member **106** may be coupled to the first arm **102** using some, all, or none of the fastener assemblies **108** A-C.

Referring to FIGS. **4** and **5**, a first fastener assembly **108**A may comprise a hook member **138** extending from the outboard end **124** of the first support member **106**. The hook member **138** may be configured to fit within and extend at least partially through an aperture **140** formed in the outboard end **105** of the first arm **102**. An extension of the hook member **138** may catch and extend over a bar portion **142** (also shown in FIG. **5**A) of the aperture **140** when the hook member **138** is inserted in the aperture **140** to secure the outboard end **124** of the first support member **106** to the outboard end **105** of the first arm **102**.

Referring to FIGS. **4**, **5**A, and **9**, the first fastener assembly **108**A may further comprise a cup member **144** formed from curved side portions **146**, **148** and a bottom surface **150**. Edges of the side portions **146**, **148** and the bottom surface **150** may align with edges of the aperture **140** formed in the outboard end **105** of the first arm **102** to form a housing that may be a motor cradle assembly **160** for receiving and partially enclosing a motor **101** as is described further, below. When the hook member **138** is inserted into the aperture **140**, the first support member **106** may be secured against displacement of the first support member **106** in the inboard-outboard direction.

Referring to FIGS. **5**A and **5**B, a second fastener assembly **108**B may comprise interlocking tabs **112**A-C extending from the ridge **118** a distance further inward and toward the center of "C" shaped cross section of the first support member **106**. The ridge **118** may extend along a length of the first support member **106** as described above. Each tab **112**A-C is configured to mate with the interlocking slot **120** positioned on an underside of the first arm **102**. Each tab **112**A-C may fit into a portion along the length of the interlocking slot **120** to establish a snug fit.

When the interlocking tabs **112**A-C are fit into the interlocking slot **120**, the first support member **106** may be secured against displacement of the first support member **106** in the inboard-outboard direction and may resist twisting of the joined structure comprising first support member **106** and first arm **102**. Although the embodiment shown is implemented with three interlocking tabs **112**, in an alternative embodiment fewer, or additional, interlocking tabs **112** may be provided. For example, in an embodiment, one continuous interlocking tab **112** may be provided that may extend along substantially the entire length of the corresponding interlocking slot **120**.

Referring to FIGS. **5**A, **5**C, **6**A, **6**B, and **7**, a third fastener assembly **108**C may comprise a series of first snap tabs **128**A-C and second snap tabs **130**A-C of the first support member **106**. The first snap tabs **128**A-C and second snap tabs **130**A-C may be disposed opposite one another along the outer surface of the "C" shaped outer profile of the first support member **106** near the open end of the "C". The first snap tabs **128**A-C and second snap tabs **130**A-C may protrude a distance outward from the outer surface of the first support member **106** and extend along a portion of the length of the first support member **106**. The first snap tabs **128**A-C and second snap tabs **130**A-C, respectively, may fit under and engage a first lip **132** and a second lip **134**, respectively, of the first arm **102** when the first support member **106** is slid into the underside of the first arm **102** as described above.

Although the embodiment shown is implemented with three first snap tabs **128** and second snap tabs **130**, in an alternative embodiment fewer, or additional, snap tabs **128** and second snap tabs **130** may be provided. For example, in an embodiment, continuous snap tabs **128**, **130** may be provided and may extend along substantially the entire length of the corresponding lips **132**, **134**.

The first lip **132** and the second lip **134**, respectively, of the first arm **102** may be disposed opposite one another along the inner surface of the "C" shaped outer profile of the first arm **102** substantially at the open end of the "C". The first lip **132** and the second lip **134** may protrude a distance inward from the inner surface of the first arm **102** and extend along a portion of the length of the first arm **102**.

The first lip **132** and second lip **134** may each be a single, continuous lip extending along substantially the whole length, or, alternatively, only a portion of the length of the first arm **102**. In another alternative embodiment, additional first lips **132** and second lips **134** may be provided, with each lip **132**, **134** extending along a portion of the length of the first arm **102** corresponding to a location of a snap tab **128**, **130** of the first support member **106**.

The first snap tabs **128**A-C and the second snap tabs **130**A-C may lock the first support member **106** to the first arm **102**, when the snap tabs **128**, **130** are engaged with the first lip **132** and the second lip **134**, respectively. Under a heavy impact, flexibility in the support member **106** may allow the first snap tabs **128**A-C and the second snap tabs **130**A-C to unsnap from the respective first lip **132** and the second lip **134** to prevent structural damage to other portions of the rotorcraft **1000**.

The rotary assembly **100** may also include a fastener assembly **108** D, as shown in FIGS. **6**A, **6**B, and **10**, for removably coupling the first support member **106** to the center pod assembly **500** at the inboard end **122** of the first support member **106**.

Referring to FIGS. **6**A, **6**B, and **10**, the fourth fastener assembly **108**D may comprise a collar **135** and a hoop member **121**. The hoop member **121** may be disposed at the inboard end **122** of the first support member **106** extend a distance along the length of the first support member **106** toward the outboard end **124**. The hoop member **121** may further extend about the cross section of the inboard end **122** of the first support member **106**, having a boundary shape as best shown in FIG. **6**A.

The hoop member **121** may abut the collar **135**, with the collar **135** disposed outboard to the hoop member **121** and extending about the cross section of the inboard end **122** of the first support member **106**. The collar **135** may form a groove around a portion of the cross section of the first support member **106**. The collar **135** may have a boundary shaped similarly to that of the hoop member **121** but sized slightly smaller than that of the hoop member **121** along each length defining the boundary shape of the hoop member **121**.

The hoop member **121** and the collar **135** may be configured to couple with the center pod assembly **500**, by engaging the collar **135** with an opening formed in the center pod assembly **500** with a perimeter shape and size substantially coincident to the boundary shape and size of the collar. The hoop member may then be trapped within the opening formed and secure the first support member to the center pod assembly **500** as described below with respect to FIG. **10**. When the hoop member **121** and collar **135** are coupled to the center pod assembly **500**, the first support member **106** may be secured against disengagement of the first support member **106** from the center pod assembly **500**, and may resist twisting of the first support member **106**.

When the first support member **106** is mated with the first arm **102**, the structure of the combination of first arm **102** and first support member **106** is configured to substantially prevent flexing and twisting of the first arm **102** and displacement of the motor relative to the center pod assembly **500**. Minimizing flexing and twisting of the first arm **102** promotes stability of control over the rotorcraft **1000** during flight and may prevent crashes.

Additionally, with the first support member **106** coupled to the first arm **102** and the center pod assembly **500** using fastening assemblies **108**A-D, as described, the need for external fasteners, such as screws, clips, inserts, and the like, to couple the rotary assembly **100** components may be greatly reduced, or eliminated. Coupling the rotary assembly **100** components as described above may provide the additional advantages of ease of assembly and disassembly, while allowing for removable coupling of the rotary assembly **100** components, notably, the first support member **106**.

In the embodiment shown and described above, the support members **106**, **206**, **306**, and **406** may be both removably coupled to the rotorcraft **1000** and be configured to function as a light pipe, capable of illuminating along the outer surfaces of the support members **106**, **206**, **306**, and **406** when receiving light from light source.

The rotorcraft **1000** may further be implemented with a support member color arrangement configurable by the user through removal and replacement of an undesired support member with one having the desired color characteristics at each rotor assembly. For example, a user may configure both forward facing support members of rotorcraft **1000** to illuminate red by replacing the forward facing support members with support members configured to illuminate red in response the light received from the light source within the center pod assembly. Users may configure the light arrangement in accordance with their color preference. The configurable light pipe feature may allow for the rotorcraft **1000** to be easier to fly in low visibility settings, such as in the evening, or in an indoor environment, and may also aid the user by allowing the orientation of the rotorcraft to be easily discerned, based on the support member color configuration, during flight. The ability to determine orientation of the rotorcraft **1000** may be further enhanced by the cut through portion **114** of the first arm, through which the illuminated light from the support member below may be seen.

With the color configuration viewable from both the top and bottom of the rotorcraft **1000**, the orientation may be determined by the user while performing tricks during flight that may cause the rotorcraft to be in an inverted position, as well as in settings where the user may operate the rotorcraft **1000** from an elevated position.

The first support member **106** may further be configured to provide aesthetically pleasing lines and features. For example, when the first support member **106** is mated with the first arm **102**, the first support member **106** may be shaped to have a curvature that follows or complements the curvature of the first arm **102** and the curvature of the center pod assembly **500**, as shown in FIGS. **1** and **5**A.

The first arm **102** and first support member **106**, as coupled may also form one or more housings for receiving and partially enclosing other rotary assembly **100** components. Referring to FIGS. **3**, **9**, and **10**, the first arm **102** and first support member **106** may couple at the outboard ends **105**, **124** of each to form a housing that may be a first motor cradle **160** for receiving and at least partially enclosing a motor **101**.

In the embodiment shown, the first motor cradle **160** may comprise a motor channel **162** extending through a portion of the outboard end **105** of the first arm **102** and in a direction that may be substantially perpendicular to the plane P1 in which the first propeller **104** rotates. It will be understood by those of ordinary skill in the art that alternative embodiments may include a motor channel **162** oriented in a direction not substantially perpendicular to the plane of rotation of the propellers, with the motor provided with a torque transfer assembly configured to accommodate the specific motor channel **162** orientation. When the first support member **106** is fully coupled to the first arm **102**, the cup member **144** may form a bottom portion of the motor cradle **160** and may substantially close the motor channel **162** at a bottom end **161**.

In the embodiment shown, the motor channel **162** may partially form a substantially cylindrical housing with dimensions configured to fit a cylindrically shaped motor, e.g. the first motor **101**. In alternative embodiments, the motor channel **162** may be configured to partially form a housing of a different shape, configured to accommodate the particular shape of the motor provided. A bottom portion of the first motor **101** may be configured to rest in the cup member **144**. The diameter of the motor channel **162** may be configured to substantially prevent shifting of the first motor **101** within the motor channel **162**.

In a particular embodiment, the first motor **101** may comprise a coreless motor of about 8.5 mm by 20 mm (8.5×20) in size and configured to provide about 3.5 to 6.0 watts (W). The first motor **101** may have an operating voltage of about 2.0-4.0 volts (V), with a no-load speed between 40000 and 50000 revolutions per minute (rpm). The motor **101** may be configured to rotate the motor shaft **109** in either of two directions about the lengthwise axis of the motor shaft **109**, as desired. It will be understood by persons of ordinary skill in the art that other types and sizes of motor may be utilized to support operation of the embodiments of the rotorcraft **1000**.

Referring to FIG. **4**, the motor channel **162** may further comprise a cut-out **165** extending through a side portion of the motor channel **162**. The cut-out **165** may conserve materials and reduce weight of the outboard end **105** of the first arm **102**. The cut-out **165** may comprise a size configured to provide sufficient structure to block displacement of the first motor **101** through the cut-out **165**.

Referring to FIGS. **5**A, **9**, and **10**, a motor channel rim forming an opening for a motor shaft may extend around a top end **163** of the motor channel **162** opposite from the cup member **144**. A top portion of the first motor **101** comprising a motor shaft **109** and motor gear **115**, such as a pinion or bevel gear, may extend through the motor shaft opening above the motor channel rim **164**. The motor channel rim **164** may comprise a diameter configured to constrain the first motor **101** within the motor channel rim **164** and prevent the motor **101** from shifting within the motor channel **162**.

Referring to FIG. **6**B, the bottom surface **150** of the first support member **106**, which may form the cup member **144**, may comprise a foot hole **141**. The foot hole **141** may comprise a size and shape configured to snugly fit a foot **143**. The foot **143** may function as a landing support and as a shock absorber protecting the first motor **101** from impact forces.

Referring to FIG. **8**, in an embodiment, the foot **143** may comprise a first flange **145** and a second flange **147** coupled by a stem **149**. The foot **143** may comprise an elastic and resiliently deformable material, such as rubber, foam, and the like.

The second flange **147** may comprise a shape such as a substantially disk, conical or semi-conical shape. The shape of the second flange **147** may be configured to be compressed, twisted, or deformed to fit into the foot hole **141** (shown also in FIG. **6**B) for installation of the foot **143**. Once fit and pushed through the foot hole **141**, the second flange **147** may expand and return to its original shape. In a particular embodiment, the second flange **147** may have a diameter of about 0.65 cm. and configured to resist removal of the foot from the foot hole **141**, while the foot hole may have a diameter of about 0.42 cm.

The first flange **145** may comprise a shape to support use of the first flange **145** as a landing support and as a shock absorber protecting the first motor **101**. A foot having substantially the same construction may be positioned at a foot hole of each other support member **206**, **306**, **406** to operate in combination to cushion landings and crashes of the rotorcraft **1000**.

The shape of the first flange may comprise a semi-spherical shape having a height and base diameter. In some embodiments, the height may comprise about 0.3 cm. and the base diameter may comprise about 0.8 cm. A central axis of the foot **143** and central axis of the motor **101** may align along line C, shown in FIG. **10**, to provide protection from shocks to the motor **101** at the bottom end of the motor **101**.

Referring to FIGS. **3**, **5**A, and **9**, in an embodiment, a portion of the first arm **102** may extend in an outboard direction from the motor channel **162** to form a housing that may be a propeller shaft cradle **170**. The propeller shaft cradle **170** may be configured to support rotation of a propeller shaft **107** coupled to the first propeller **104**. The propeller shaft cradle **170** may comprise a propeller shaft channel **174** extending through a portion of the outboard end **105** of the first arm **102** in a direction substantially perpendicular to the plane P**1** in which the first propeller **104** rotates. The propeller shaft channel **174** may be offset from the motor channel **162** in an outboard direction relative to the inboard end **103** of the first arm **102**.

The propeller shaft channel **174** may comprise a diameter configured to receive a propeller shaft **107** and bearings **117**A, B for supporting rotation of the shaft **107**. The propeller shaft channel **174** may be open at a top end to allow the propeller shaft **107** to extend above the top end of the propeller shaft channel **174** and to couple to the first propeller **104**.

The propeller shaft cradle **170** may further comprise spokes **175**A-E extending from the outer surfaces of the propeller shaft channel **174**. The spokes **175**A-E may extend to a gear rim **176**. The gear rim **176** may comprise a substantially circular shape centered about the propeller shaft channel **174**, and the circular shape may extend in a plane substantially parallel to the plane in which the first propeller **104** rotates. The spokes **175**A-E may provide structural support and stability to the gear rim **176** and substantially prevent flexing of the gear rim **176** relative to the propeller shaft channel **174**.

The propeller shaft cradle **170** may further comprise cradle brace members **173**A and **173**B. Each brace member **173**A, B may bridge the offset between motor channel **162** and the propeller shaft channel **174**. Each cradle brace member **173**A, B may comprise a plate extending from edges of the cut-out **165** in the motor channel **162** to the side surfaces of the propeller shaft channel **174**. Brace members **173**A, B may provide support and stability to the propeller shaft channel **174** to prevent relative displacement between the first motor **101** and first propeller **104**, including the gearing that ties the two components.

The first motor cradle **160** and the propeller shaft cradle **170** may be further supported from flexing, which may cause instability in powered flight, by bracing members **167**A and **167**B supporting an inboard side of the first motor cradle **160**. The bracing members **167**A, B may comprise a curved structure extending from a surface of the first arm **102** to a side surface of the first motor cradle **160**. The curved surface may function substantially to prevent pitching during flight or in response to a hard landing of the first motor cradle **160** and the propeller shaft cradle **170** back towards the center pod assembly **500**.

Referring to FIGS. **2**, **4**, **5**A, **9**, and **10**, in an embodiment, the rotor assemblies **100**, **200**, **300**, and **400** may further comprise a torque transfer assembly **180**. In reference to the first rotor assembly **100** components, the torque transfer assembly **180** may operably couple the motor shaft **109** to the first propeller **104**. In some embodiments, the torque transfer assembly **180** may comprise the motor gear **115** fixed to the motor shaft **109**.

In some embodiments, torque is transferred to the motor gear **115** from the motor shaft **109** by a non-circular "D" shaped portion of the motor shaft. A central aperture in the motor gear **115** for receiving the motor shaft **109** may comprise a matching D-shape. The D-shape in the motor shaft may be machined flat at an initially circular section in the motor shaft **109**. In other embodiments, the motor gear **115** may be attached to the motor shaft **109** by chemical bonding or by mechanical fasteners, such as a pin. In other embodiments, the motor gear **115** is formed integrally with the motor shaft **109**.

In an embodiment, the torque transfer assembly **180** may further comprise a first gear **182** mounted co-axially with the propeller shaft **107** in the propeller shaft cradle **170**. The first gear **182** may be configured to mechanically mesh with the motor gear **115** to transfer torque from the motor shaft **109** to the propeller shaft **107** and to support powered flight of the rotorcraft **1000**. In a particular embodiment, the gear reduction ratio between the motor gear **115** and first gear **182** may be about 78/11 or 7.1:1.

The propeller shaft **107** and first propeller **104** may be mounted in the propeller shaft cradle and supported for rotation by a first bearing **117**A and a second bearing **117**B. The first bearing **117**A may be a ball bearing with a central aperture. The first bearing **117**A may be positioned against a first internal ridge **166**A that extends along the internal walls of propeller shaft channel **174** proximal to the bottom end of the propeller shaft channel **174**.

The propeller shaft **107** may comprise a shaft ridge **119** at a base end of the propeller shaft **107**. The propeller shaft **107** may be inserted axially into the bottom end of the propeller shaft channel **174** and through the central aperture of the first bearing **117**A to constrain the first bearing **117**A between the shaft ridge **119** and the first internal ridge **166**A.

The second bearing **117**B may comprise a ball bearing with a central aperture and may be positioned against a second internal ridge **166**B that extends along internal walls of the propeller shaft channel **174** proximal to the top end of the propeller shaft channel **174**. The propeller shaft **107** may extend through the central aperture of the second bearing **117**B and through the top end **163** of the propeller shaft channel **174**.

A portion of the propeller shaft **107** may extend out of and above propeller shaft channel **174**. The propeller shaft **107** may comprise a non-circular profile **169** extending along a length of the propeller shaft **107**. The non-circular profile **169** may be configured to extend through a central aperture in the first gear **182** and mate with a non-circular profile of the central aperture for the transfer of torque from the first gear **182** to the propeller shaft **107**.

The first gear **182** may be mounted on the shaft **107** between the second bearing **117**B and the first propeller **104**. The first gear **182** may be positioned substantially within the perimeter of the gear rim **176**. A portion of the gear rim **176** may extend above the plane in which the first gear **182** rotates, providing protection to the first gear **182** from foreign objects impacting the first gear **182** from above. The spokes **175**A-E, which may extend in a plane beneath the plane in which the first gear **182** rotates, providing protection to the first gear **182** from impacts to the first gear **182** from foreign objects approaching from beneath the first gear **182**. The first propeller **104**, which may also extend and rotate in a plane above the plane in which the first gear **182** rotates, may also provide protection to the first gear **182** from foreign objects approaching from above the first gear **182**.

The non-circular profile **169** of the propeller shaft **107** may be further configured to extend through a central aperture a hub channel **133** of a hub **125** of the first propeller **104**. The non-circular profile **169** may mate with a non-circular profile of the hub channel **133** to support the transfer of torque from the propeller shaft **107** to the first propeller **104**.

In some embodiments, the propeller shaft **107** may be coupled to the first propeller **104** by a fastener **123**, which may be a screw having a head portion. The fastener **123** may extend through a hub aperture **131** in the hub **125** of the first propeller **104** and threadably couple to a shaft aperture **168**, which may extend axially through the portion of the propeller shaft **107** located within the hub channel **133**. The head portion of the screw may be advanced until it sets against a hub ridge within the hub **125** to secure the first propeller **104** to the propeller shaft **107**.

Referring to FIG. **4**, the center pod assembly **500** may comprise a first cover **502** and base **504** coupled to form a housing for partially, or substantially, enclosing the control components of the rotorcraft **1000**. The base **504** may be configured to be removable from the first cover **502**. As shown in FIGS. **11**B and **12**, in an embodiment, the base **504** may be secured with fasteners **530**A-D, for example, screws, extending through base apertures **532**A-D and threadably coupling into corresponding apertures (not shown) in the underside of the first cover **502**.

In some embodiments, the first cover **502** and arms **102**, **202**, **302**, and **402** may be integrally formed from a single piece of material. In such embodiments, the material forming the single piece comprising the first cover **502** and arms **102**, **202**, **302**, **402** may be composed of a nylon, or similar, material. Alternatively, the first cover **502** and arms **102**, **202**, **302**, and **402** may, instead, be separate components and may be coupled to one another.

In an embodiment, the base **504** may be composed of nylon, or similar, material. It will be understood by persons of ordinary skill in the art that the components of the center pod assembly **500** may be made from other suitable materials (e.g. plastics, metals, wood, and composites) based on the requirements for flight of the rotorcraft **1000** and other structural, aesthetic, and cost factors.

Referring to FIGS. **4** and **11**A-C, in an embodiment, the base **504** may comprise a mounting surface **505**, side walls **508**A-D, a plurality of light receptacles **510**, a plurality of light openings **512**, a plurality of front walls **513**, and a plurality of locator recesses **518**. In an alternative embodiment, the base **504** may comprise additional, fewer, or different components.

The base **504** may be implemented with side walls **508**A-D for at least partially enclosing the controls components, which, in an embodiment, may include a printed circuit board assembly (PCBA) **506**, a battery (not shown), and a plurality of light sources **511**A-E,

In an embodiment, the side walls **508**A-D may each be oriented to form a substantially vertical surface, as best shown in FIG. **11**A. The side walls **508**A-D may extend upward from a substantially horizontally oriented surface, a mounting surface **505**. The mounting surface **505** may extend a distance inward from the lower edge of the side walls **508** along the perimeter of the base **504** for receiving and coupling components to the base **504**.

As shown in the embodiment of FIG. **11**A, the light receptacles **510**A-D may extend from the corners where the side surfaces **508**A-D meet. Each light receptacle **510**A-D may comprise a generally trapezoidal shaped area that may partially enclose a light source **511**A-D, respectively. In an embodiment, the front walls **513**A-D may form the outermost surface defining the trapezoidal shape, as best shown in FIG. **11**A. The front walls **513**A-D may each be implemented with a cutout portion, forming light openings **512**A-E.

The light openings **512**A-E may be configured to have boundary shape that is substantially coincident with the cross sectional shape of the collar **135** of the support members **106**, **206**, **306**, and **406**. As described above, the support members **106**, **206**, **306**, and **406** may couple to the base **504**, with the collar **135** sliding into the light openings **512** A-D, trapping the hoop members **121** within the light receptacles **510** A-D when the base **504** is coupled to the first cover **502**.

The light openings **512** A-E may also provide a passage through which light emitted by the light sources **511** A-E may reach the exterior of the coupled center pod assembly **500**, accessing the inboard ends of the support members **106**, **206**, **306**, and **406**.

Referring to FIG. **12**, the light sources **511**A-E may be disposed within the center pod assembly **500** and within the substantially horizontal plane of the PCBA **506**. The light sources **511**A-E may be oriented to face away from PCBA **506** and toward light receptacles **510**A-E, so the light sources **511**A-E may emit light in a direction substantially towards and through light openings **512**A-E.

In an embodiment, the light sources **511**A-E may be configured to emit light of any frequency within the visible spectrum. Further, in an embodiment, each light source **511**A-E may be configured to emit light of the same color, for example, each light source may be configured to emit substantially 'white' light, or, alternatively some or all of light sources **511**A-E may be configured to emit different 'colors' of light.

In an embodiment, the light sources **511**A-E may be light emitting diodes (LED). In alternative embodiments, the light source may be an incandescent lamp, electroluminescent lamp, gas discharge lamp, laser, or the like.

In an embodiment, and as shown in FIGS. **12** and **13**B, each of the light sources **511**A-E may be implemented with a locator **519**A-E. The locators **519**A-E may be made from a flexible or compliant material such as rubber, plastic, foam, or the like that may be resilient and capable of elastic deformation. The locators **519**A-E may be sized to stretch and fit around a light source **511**A-E, coupling snugly to the light source **511** and maintaining frictional contact along substantially the entire portion of the light source **511** to which the locator **519** is attached.

In a particular embodiment, for example, LEDs may be provided as a light source and rubber, or plastic, O-rings may be provided as a locator. In such an embodiment, the O-ring may be configured to have an internal circumference length of slightly less than the perimeter length of the LED to which the O-ring is applied. The O-ring may be stretched to fit over the LED and grip the LED along the O-ring inner surface, providing frictional resistance to removal of the placed O-ring. With the O-ring in place, the LED may be positioned, oriented, and secured in place through fixing the location of the affixed O-ring.

Referring to FIGS. **11**, **12**, and **13**A-C, in an embodiment, the base **504** may further comprise a plurality of locator recesses **518**A-D for receiving, positioning, and securing locators **519**A-D, thereby setting the location and orientation of the light source **511**A-D to which the locator **519**A-D is affixed. The locator recesses **518**A-D may each be a downwardly extending depression formed into the mounting surface **505** and disposed at the lower portion of each light receptacle **510**A-D. The locator recesses **518**A-D may be configured to direct the light emitted from the received light source **511**A-D in a desired direction, such as towards a light opening **512**A-D so that the light may access the inboard ends of the support members **106**, **206**, **306**, and **406**.

In an embodiment, a fifth locator recess **518**E may be provided for setting the location and orientation of the tail-light, light source **511**E. The locator recess **518**E may be located adjacent to side surface **508**A and may also be configured to support, position, and secure a light source **511**E, so that the light source **519**E may partially pass through the light opening **512**E.

Referring to FIG. **12**, the first cover **502** may comprise locator cradles **520**A-D extending from an undersurface of the first cover **502** at the base of each arm **102**, **202**, **302**, and **402**. Each locator cradle **520**A-D may comprise a first column **522**A-D spaced from a second column **523**A-D. The width between the first column **522**A and the second column **523**A may be configured to snugly fit each respective locator **519**A-D mounted around each respective light source **511**A-D in an interference fit. A locator cradle **520**E may be configured in a similar manner to locator cradles **520**A-D for supporting the light source **511**E. The locator cradle **520**E may comprise a first column **522**E and second column **523**E spaced from each other for snugly fitting the light source **511**E, having the locator **519**E between the columns **522**E, **523**E.

As shown in FIGS. **11**B, **12**, **13**B, and **13**C, in an embodiment the locator cradles **520**A-E may be disposed and oriented within the first cover **502** at locations corresponding to, and aligning with the locations of the locator recesses **518**A-E of the base **504**, so that the locator cradles **520**A-E and the locator recesses **518**A-E may simultaneously receive the locators **519**A-E when the base **504** and first cover **502** are coupled. In alternative embodiments, the locator recesses **518**, alone, or, alternatively, the locator cradles **520**, alone, may be provided for receiving and setting the position of the locators **519** and light sources **511** provided.

Referring to FIG. **4**, the PCBA **506** may comprise a main circuit board including components **507** that would be known to persons of ordinary skill in the art, including but not limited to a control processor, a transceiver, a radio-frequency antenna, sensors (e.g. gyroscopic sensors and accelerometer sensors) motor controllers, and a data interface. The PCBA **506** may also comprise power connectors for each light source **511**A-E.

Referring to FIGS. **12** and **13**C, the light sources **511**A-E may couple to the PCBA **506** at locations along the perimeter of the PCBA **506**. Referring to FIGS. **4**, **12**, and **13**A-C, in a particular embodiment, the light sources **511**A-E may be implemented with locators **519**A-E and sets of leads **526**A-E for electrically coupling the light sources **511**A-E to the PCBA **506**. Each set of leads **526**A-E may comprise substantially rigid metal conductors, and may be soldered to the circuit board of the PCBA to create a substantially rigid connection between each light source **511**A-E and the circuit board.

According to the embodiment shown in FIGS. **12** and **13**C, the PCBA **506** may be coupled to the underside of the first cover **502** by setting each light source **511**A-E having a locator **519**A-E mounted around each light source **511**A-E into each respective locator cradle **520**A-E so that each locator **519**A-E is snugly fit in an interference fit with each locator cradle **520**A-E. In this configuration, the circuit board of the PCBA **506** may be coupled to the first cover **502** without making contact with any internal surfaces of the first cover **502**.

The base **504** may be coupled to the first cover **502** as described above, and locator recesses **518**A-E may receive the lower portion of the locators **519**A-E and fix the location of each light source **511**A-E within the center pod assembly **500**. The PCBA **506** may be operably coupled to both the first cover **502** and base **504** within the formed center pod assembly **500** without the PCBA **506** contacting any portion of the interior surface of the center pod assembly **500**.

In this arrangement, the PCBA **506** may also be vibrationally isolated from the center pod assembly **500** and rotor assembly **100**, **200**, **300**, and **400** components. The resilient and elastically deformable material of the locators **519**A-E may provide vibration absorbing protection to the PCBA **506**, insulating the PCBA **506** from impacts during rotorcraft **1000** operation as well as from vibrations induced into the rotorcraft **1000** through rotation of the propellers **104**, **204**, **304**, and **404**.

Vibrationally isolating the controls components of the rotorcraft **1000** may provide the advantages of prolonging the useful life of the rotorcraft **1000** through increased crash damage resistance and may also improve rotorcraft control and stability during flight, with the controls components protected from vibrations that may affect data collected by controls components for use in flight control.

Referring to FIG. **2**, the first cover **502** may further comprise cover members **528**A-D comprising bars crossing between opposing first and third arms **102**, **302** and second and fourth arms **202**, **402**. The cover members **528**A-D may be configured to crossover the PCBA **506** and provide protection to the PCBA **506** from impacts and foreign objects. It will be understood by persons of ordinary skill in the art that the cover members **528**A-D may form other patterns or form a continuous surface according to design requirements for the rotorcraft **1000**.

Referring to FIGS. **3** and **4**, the first cover **502** may further comprise a connector clip **536** configured to hold a power connector (not shown) extending from the circuit board of the PCBA **506**. The connector clip **536** may comprise a shelf **538** extending generally perpendicular to the side surface **508**C. A rail **539** may extend from an end of the shelf **538** generally parallel to the side surface **508**C.

A tab **540** may extend from an end of the rail **539**. The side surface **508**C, shelf **538**, and rail **539** may form at least a partially enclosed space for retaining a power connector configured to plug into a connector from a battery (not shown). The tab **540** may be configured to clip onto a side surface of a power connector to lock the power connector into place. The shelf **538** and rail **539** may be bent away from the side surface **508**C to release the tab **540** from the power connector.

Referring to FIG. **11**, the base **504** may further comprise a battery receptacle **514** configured to hold a substantially prismatically-shaped battery (not shown) to support operation of the rotorcraft **1000**. The battery receptacle **514** may comprise support plates **515**A, B extending within a first plane and cross bars **516**A, B extending within a second plane offset from the first plane.

The cross bars **516**A, B may be offset from each other by distance configured to support a length of a battery. A support beam **517** may extend between the cross bars **516**A, B to further support an underside of a battery. The cross bars **516**A, B may further comprise an approximately ninety (90) degree bend configured to accommodate a depth of a battery and support sides of the battery.

The battery may be inserted in the battery receptacle **514** through a battery opening **521** in the base **504** and slid into the space formed by and between the support plates **515**A, B and the cross bars **516**A, B. The tabs **524**A, B may extend in a direction substantially perpendicular to the direction of insertion of the battery and may function as stops to prevent the battery from falling out through an opening in the battery receptacle **514** opposite from the battery opening **521**. Additionally, the tabs **524**A, B may allow the battery to be aligned properly with the center of gravity C**1**.

Referring to FIGS. **1** and **4**, the center pod assembly **500** may further comprise a pod cover **542** configured to couple on a top surface of the first cover **502**. The pod cover **542** may comprise aesthetically pleasing curvatures, designs, and other features. In some embodiments, the pod cover **542** may be made of a plastic, and may further comprise a two-tone plastic, for example black and red.

Referring to FIGS. **2**, **4**, and **12**, the pod cover **542** may couple to the first cover **502** by fasteners **535**A-C (e.g. screws) extending through second cover apertures **534**E-G in the pod cover **542** and threadably coupling with corresponding apertures (not shown) in the underside of the pod cover **542**.

Having thus described the present invention by reference to certain of its exemplary embodiments, it is noted that the embodiments disclosed are illustrative rather than limiting in nature and that a wide range of variations, modifications, changes, and substitutions are contemplated in the foregoing disclosure and, in some instances, some features of the present invention may be employed without a corresponding use of the other features. Additional details are presented the Appendix attached hereto and incorporated by reference for all purposes. Many such variations and modifications may be considered desirable by those skilled in the art based upon a review of the foregoing description of exemplary embodiments. Accordingly, it is appropriate that any claims supported by this description be construed broadly and in a manner consistent with the scope of the invention.

The invention claimed is:

1. A radio controlled model rotorcraft, comprising:
a first cover, comprising at least one support frame;
at least one light source disposed adjacent the first cover; and
a plurality of rotor assemblies, each rotor assembly comprising at least one motor;
at least one rotor assembly further comprising:
an arm having a longitudinal length extending outwardly from the first cover, the arm comprising at least one illuminating arm portion extending longitudinally along at least a portion of the length of the arm and comprising material in the range of at least translucent to fully transparent; and
wherein the at least one motor is mounted on the arm;
wherein the at least one illuminating arm portion receives and transmits light longitudinally along at least a portion of the length of the arm from the at least one light source disposed adjacent the first cover and illuminates in response to the light received and transmitted; and
wherein the arm is configured to allow substantially unobstructed transmission of at least a portion of light emitted by the at least one light source to the at least one illuminating arm portion.

2. The radio controlled model rotorcraft of claim **1**, wherein the at least one illuminating arm portions further comprise one or more coupling members integrally formed with the illuminating arm portion for removably coupling the illuminating arm portion to the arm, wherein the illuminating arm portion and the arm are coupled without the use of additional fastening devices configured to directly contact the illuminating arm portion.

3. The radio controlled model rotorcraft of claim **1**, wherein the at least one illuminating arm portion comprises a single piece of material in the range of at least translucent to fully transparent.

4. The radio controlled model rotorcraft of claim **1**, further comprising:
the at least one rotor assembly further comprising:
one or more foot members, each composed of a resiliently deformable material; and
wherein at least one of the one or more foot members is disposed beneath the at least one motor, providing landing support and impact resistance to the at least one rotor assembly.

5. The radio controlled model rotorcraft of claim **4**, wherein at least one of the one or more foot members is received by the arm.

6. The radio controlled model rotorcraft of claim **1**, further comprising:
one or more electrically conductive wires;
wherein the arm further comprises a channel extending along at least a portion of the length of the arm; and
wherein at least a portion of the length of at least one of one or more wires is at least partially enclosed within the channel.

7. The radio controlled model rotorcraft of claim **1**, further comprising a pod cover configured to removably couple to the first cover.

8. The radio controlled model rotorcraft of claim **1**, further comprising:
the at least one illuminating arm portion comprising a first end proximal to the first cover; and
wherein the at least one illuminating arm portion receives at least a portion of the light emitted by the at least one light source substantially at the first end of the at least one illuminating arm portion.

9. The radio controlled model rotorcraft of claim **1**, wherein the at least one illuminating arm portion is configured to be removably couplable to the at least one rotor assembly.

10. The radio controlled model rotorcraft of claim **9**, further comprising:
the first cover comprising one or more openings, with each opening extending through one or more surfaces of the first cover;
the at least one rotor assembly further comprising:
the at least one illuminating arm portion comprising a first end proximal to the first cover and a groove disposed proximal to the first end; and
wherein at least one of the one or more openings is configured to receive at least a portion of the groove of the at least one illuminating arm portion, at least partially coupling the at least one illuminating arm portion to the first cover.

11. The radio controlled model rotorcraft of claim **1**, wherein the at least one illuminating arm portion is configured to have one or more specific illuminating colors in response to received light.

12. The radio controlled model rotorcraft of claim **11**, wherein the at least one illuminating arm portion is removably coupled to the at least one rotor assembly of the rotorcraft, whereby the color arrangement of the at least one illuminating arm portion of the at least one rotor assembly is configurable through replacement of one or more of the at least one illuminating arm portions with one or more illuminating arm portions having the desired illuminating color, or colors.

13. The radio controlled model rotorcraft of claim **11**, wherein the at least one light source is configured to emit substantially white light.

14. The radio controlled model rotorcraft of claim **1**, wherein the arm further comprises one or more openings through one or more surfaces of the arm; and wherein at least a portion of the at least one illuminating arm portion is viewable through at least one of the one or more openings through the arm.

15. The radio controlled model rotorcraft of claim **1**, further comprising:

a center housing comprising the first cover and a base member, wherein the first cover and the base member are configured to couple to one another, the center housing further comprising one or more openings through a surface of the center housing; and

wherein at least one of the openings is configured to receive the at least one illuminating arm portion of the at least one rotor assembly, coupling the at least one illuminating arm portion to the center housing.

16. The radio controlled model rotorcraft of claim **1**, wherein the number of light sources corresponds to at least the number of rotor assemblies, wherein the arm of the at least one rotor assembly is optically paired with, and receives light most intensely from, a single light source from among the at least one light sources disposed adjacent the first cover.

17. The radio controlled model rotorcraft of claim **1**, wherein the

at least one illuminating arm portion comprises at least a portion of one or more one or more external surfaces of the arm.

18. The radio controlled model rotorcraft of claim **1**, wherein at least one of the one or more foot members is received by the at least one illuminating arm portion to operatively provide landing support for the at least one rotor assembly.

19. The radio controlled model rotorcraft of claim **1**, wherein the at least one light source is disposed at least partially within the first cover.

20. The radio controlled model rotorcraft of claim **19**, wherein the at least one light source is configured to emit light most intensely in one or more first directions, the at least one light source oriented with at least one of the one or more first directions substantially aligned with the direction of extension of the arm.

21. The radio controlled model rotorcraft of claim **19**, the arm further comprising:

a first surface extending along a portion of the length of the arm and disposed internal to the arm;

a second surface extending along a portion of the length of the arm and disposed internal to the arm, wherein the second surface is disposed below, and facing substantially toward, the first surface; and

wherein at least one light source is configured to emit light onto both the first and second surfaces internal to the arm.

22. The radio controlled model rotorcraft of claim **19**, further comprising:

a circuit board disposed within the first cover; and

wherein the at least one light source is electrically coupled directly to the circuit board.

23. The radio controlled model rotorcraft of claim **19**, wherein the arm is configured to allow substantially unobstructed transmission of at least a portion of light emitted by the at least one light source through the arm to the at least one illuminating arm portion.

24. A radio controlled model rotorcraft, comprising:

a first cover, comprising at least one support frame;

a plurality of arms, each arm extending outwardly from the first cover and comprising:

a first end proximal to the first cover;

a second end distal to the first cover and configured to at least partially receive a motor; and

at least one support member;

one or more light sources disposed at least partially within the first cover;

wherein the first cover and at least a portion of each of the plurality of arms comprise a single piece of material;

wherein each of the support members is configured to extend along substantially the entire length of the respective arm of the plurality of arms, from the first end to the second end of the respective arm;

wherein at least the first end of each of the arms is composed of material in the range of at least translucent to fully transparent;

wherein each of the arms is configured to allow substantially unobstructed transmission of at least a portion of light emitted by at least one of the one or more light sources to the respective support member of the arm at the first end of the arm; and

wherein each of the support members illuminates along at least a portion of its length in response to light received from at least one of the one or more light sources disposed at least partially within the first cover.

25. A radio controlled model rotorcraft, comprising:

a first cover, comprising at least one support frame;

a plurality of rotor assemblies, each rotor assembly comprising at least one motor;

at least one rotor assembly further comprising:

an arm extending outwardly from the first cover, the arm comprising at least one light transmitting portion allowing transmission of light along at least a portion of the length of the arm, the light transmitting portion of the arm comprising at least one illuminating arm portion extending longitudinally along at least a portion of the arm, the at least one illuminating arm portion comprising material in the range of at least translucent to fully transparent; and

wherein the at least one motor is mounted on the arm;

at least one light source configured to emit light most intensely in a first direction substantially aligned with the direction of extension of at least a portion of the light transmitting portion of the arm;

wherein at least a portion of the light emitted by the at least one light source is emitted toward at least a portion of the at least one illuminating arm portion;

wherein the at least one illuminating arm portion receives and transmits light longitudinally along at least a portion of the length of the arm from the at least one light source and illuminates in response to the light received and transmitted; and

wherein the arm is configured to allow substantially unobstructed transmission of at least a portion of light emitted by the at least one light source to the at least one illuminating arm portion.

26. The radio controlled model rotorcraft of claim **25**, the arm further comprising:

a first internal surface extending along a portion of the length of the arm;

a second internal surface extending along a portion of the length of the arm, wherein the second surface is disposed below, and facing substantially toward, the first surface; and wherein at least one light source is configured to emit light onto both the first and second surfaces.

27. A radio controlled model rotorcraft, comprising:

a first cover, comprising at least one support frame;

a circuit board secured to the first cover;

at least one light source directly coupled to the circuit board; and

a plurality of rotor assemblies, each rotor assembly comprising at least one motor;

at least one rotor assembly further comprising:

an arm having a longitudinal length extending outwardly from the first cover, the arm comprising at least one illuminating arm portion extending longitudinally along at least a portion of the length of the arm and comprising material in the range of at least translucent to fully transparent; and

wherein the at least one motor is mounted on the arm;

wherein the at least one illuminating arm portion receives and transmits light longitudinally along at least a portion of the length of the arm from the at least one light source and illuminates in response to the light received and transmitted; and

wherein the arm is configured to allow substantially unobstructed transmission of at least a portion of light emitted by the at least one light source to the at least one illuminating arm portion.

28. The radio controlled model rotorcraft of claim **27**, wherein the at least one light source is secured to the circuit board.

29. The radio controlled model rotorcraft of claim **27**, wherein the at least one light source is electrically connected directly to the circuit board.

30. The radio controlled model rotorcraft of claim **27**, wherein the arm is configured to allow substantially unobstructed transmission of at least a portion of light emitted by the at least one light source through at least a portion of the length of the arm to the at least one illuminating arm portion.

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