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**Yu**

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(54) **ROTOR SHROUDING APPARATUS, SUPPORTING ASSEMBLY, AND UNMANNED AERIAL VEHICLE USING THE SAME**

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**B64C 27/00** (2006.01)  
**A63H 27/00** (2006.01)

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

CPC ..... **B64C 39/024** (2013.01); **A63H 27/12** (2013.01); **B64C 11/001** (2013.01); **B64C 27/006** (2013.01); **B64C 27/08** (2013.01);

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,322,648 B2 \* 12/2012 Kroetsch ..... B64C 39/024  
244/17.23  
8,794,564 B2 \* 8/2014 Hutson ..... B64C 27/006  
244/17.17  
8,973,861 B2 \* 3/2015 Zhou ..... B64C 27/20  
244/17.23  
2015/0129711 A1 \* 5/2015 Caubel ..... B64C 27/08  
244/17.23  
2015/0321759 A1 \* 11/2015 Caubel ..... B64C 39/024  
244/17.23

(Continued)

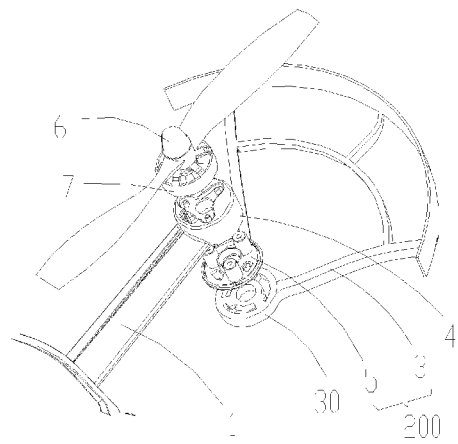
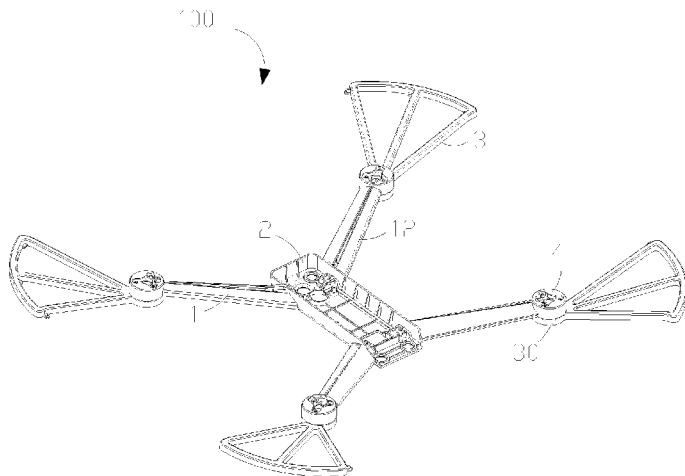
FOREIGN PATENT DOCUMENTS

CN 203318681 12/2013  
*Primary Examiner* — Richard R Green

(57) **ABSTRACT**

A supporting assembly for an unmanned aerial vehicle is disclosed. The supporting assembly includes a base, rotor arms, and rotor shrouds. The rotor arms extend from the base. Each of the rotor arms includes a proximal end secured to the base and a distal end opposite to the proximal end. Each of the rotor shrouds includes a converged end removably engaged with and secured to the distal end, an arc shaped end, and one or more connecting members extending from the arc shaped end to the converged end. An unmanned aerial vehicle and a rotor shroud apparatus are also disclosed.

**19 Claims, 10 Drawing Sheets**



(56)

**References Cited**

U.S. PATENT DOCUMENTS

2016/0221671 A1\* 8/2016 Fisher ..... B64C 27/08  
2016/0297545 A1\* 10/2016 Yang ..... B64C 39/024  
2016/0318615 A1\* 11/2016 Pick ..... B64C 39/024  
2017/0043869 A1\* 2/2017 Howard ..... B64C 27/08

\* cited by examiner

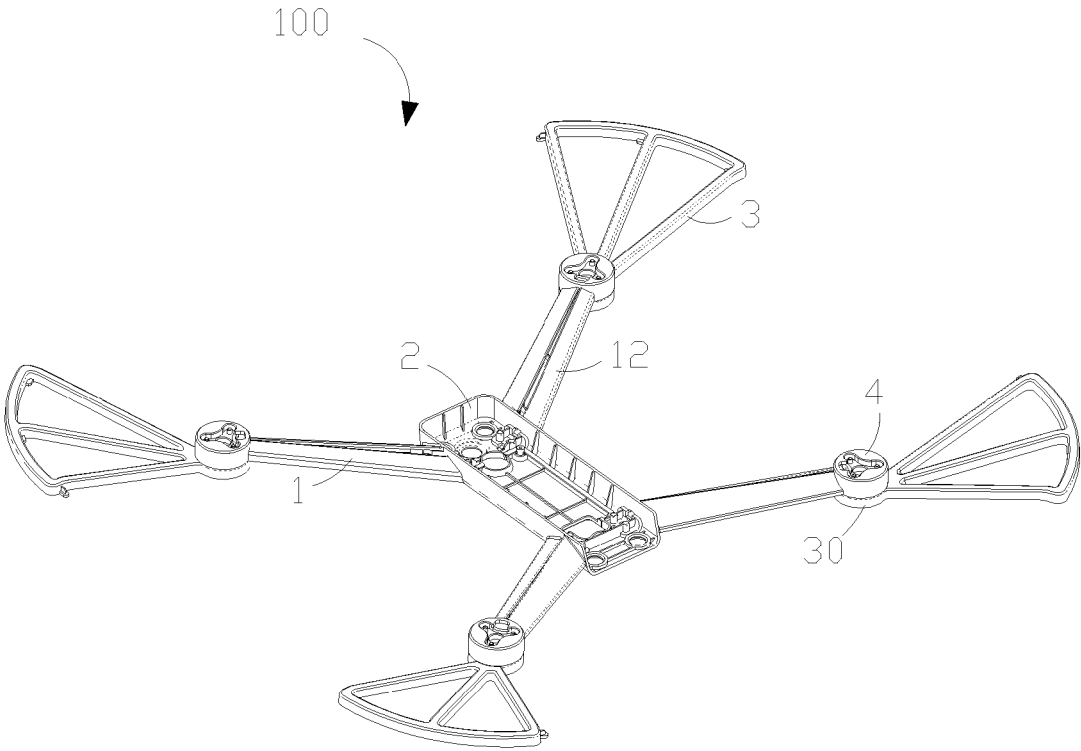


FIG. 1

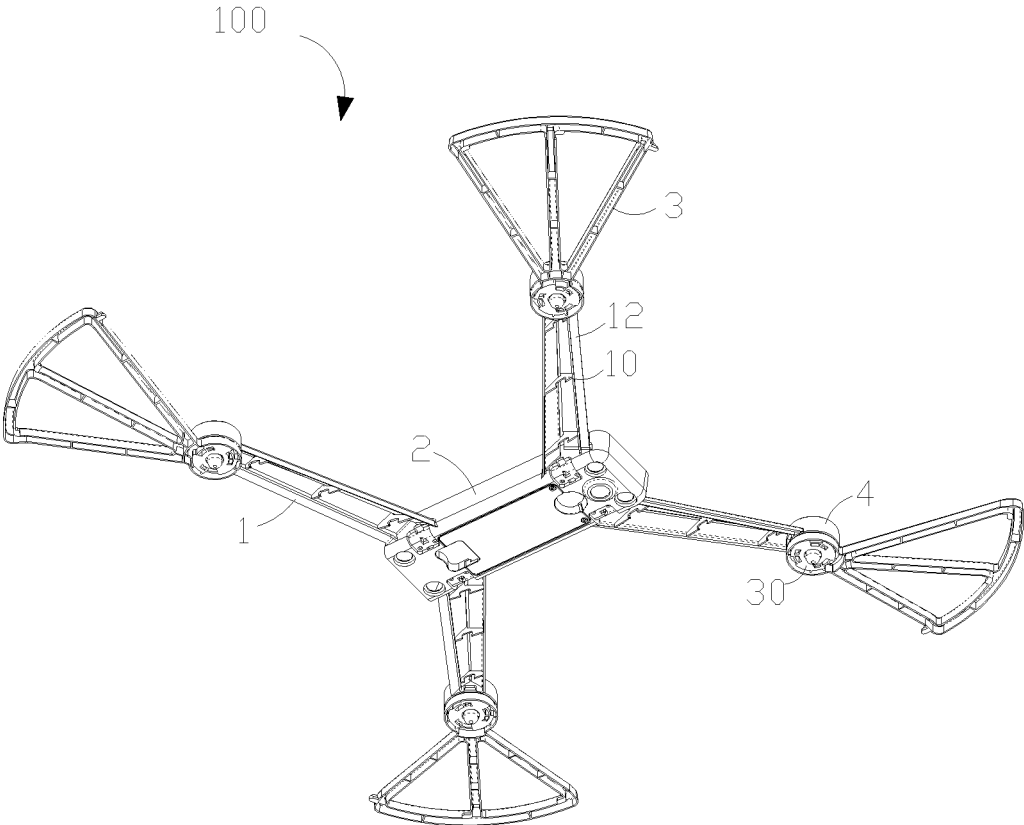


FIG. 2

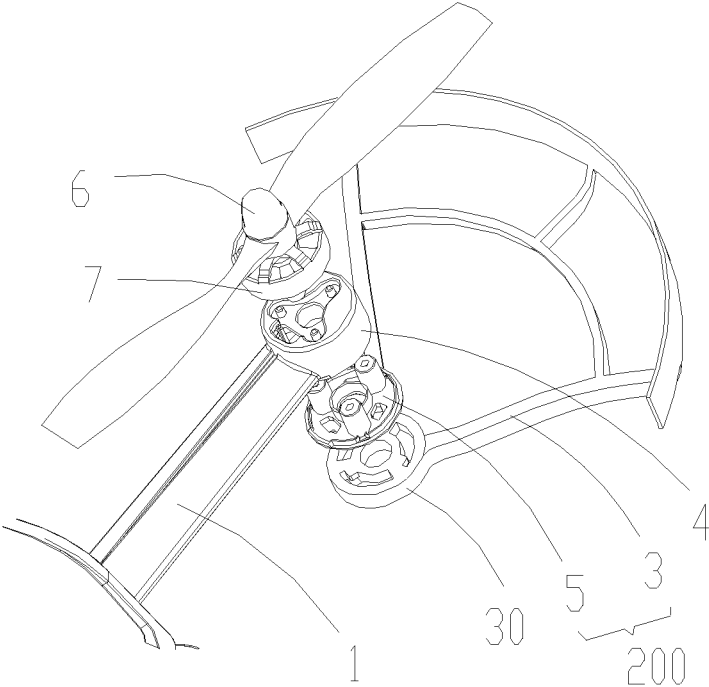


FIG. 3

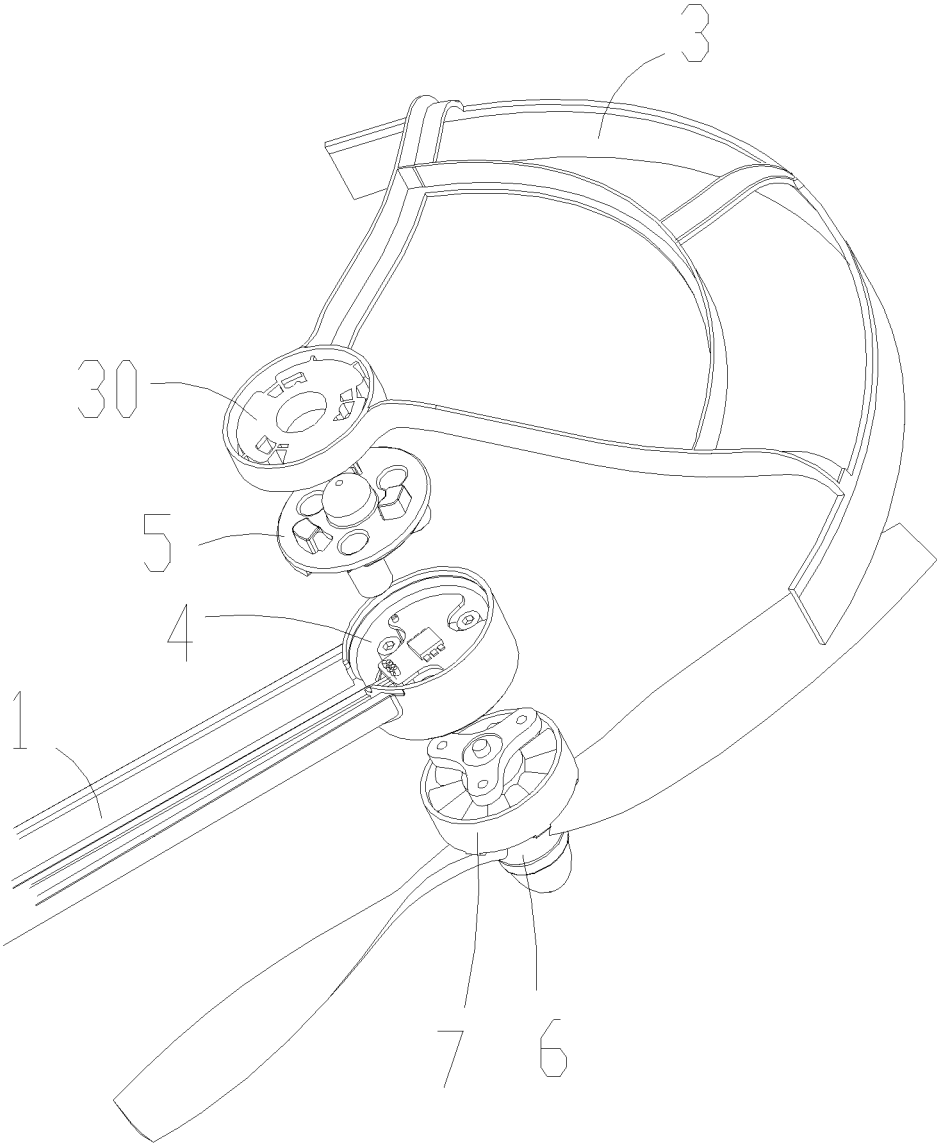


FIG. 4

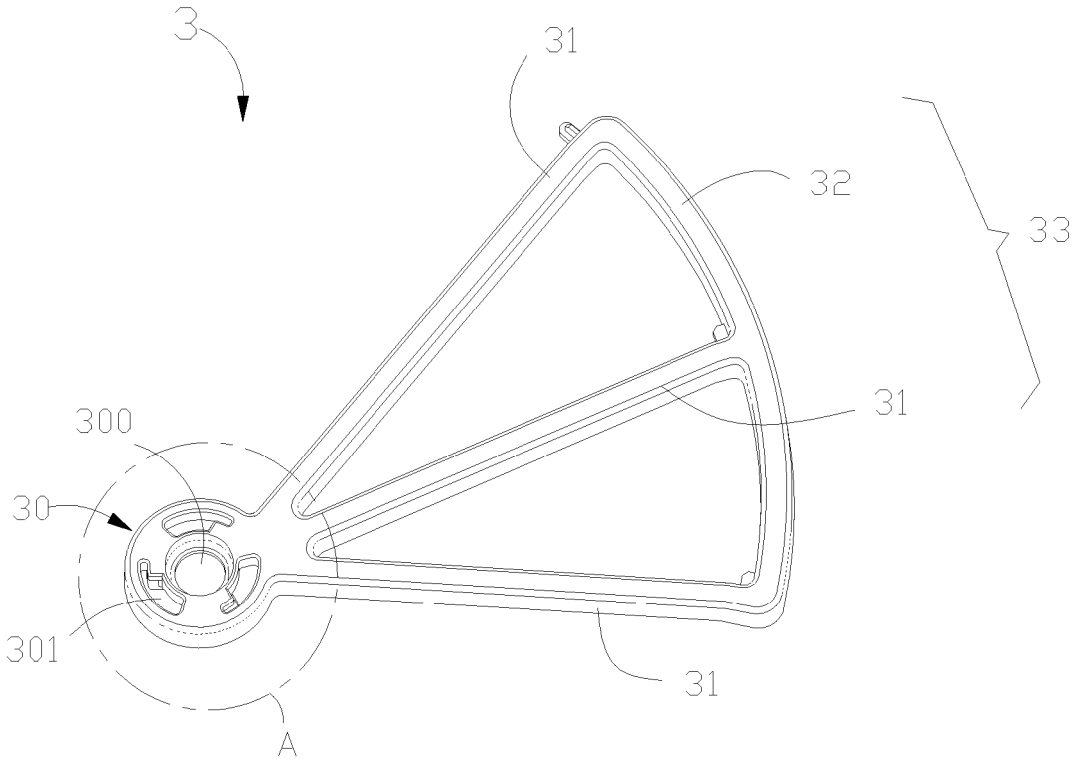


FIG. 5

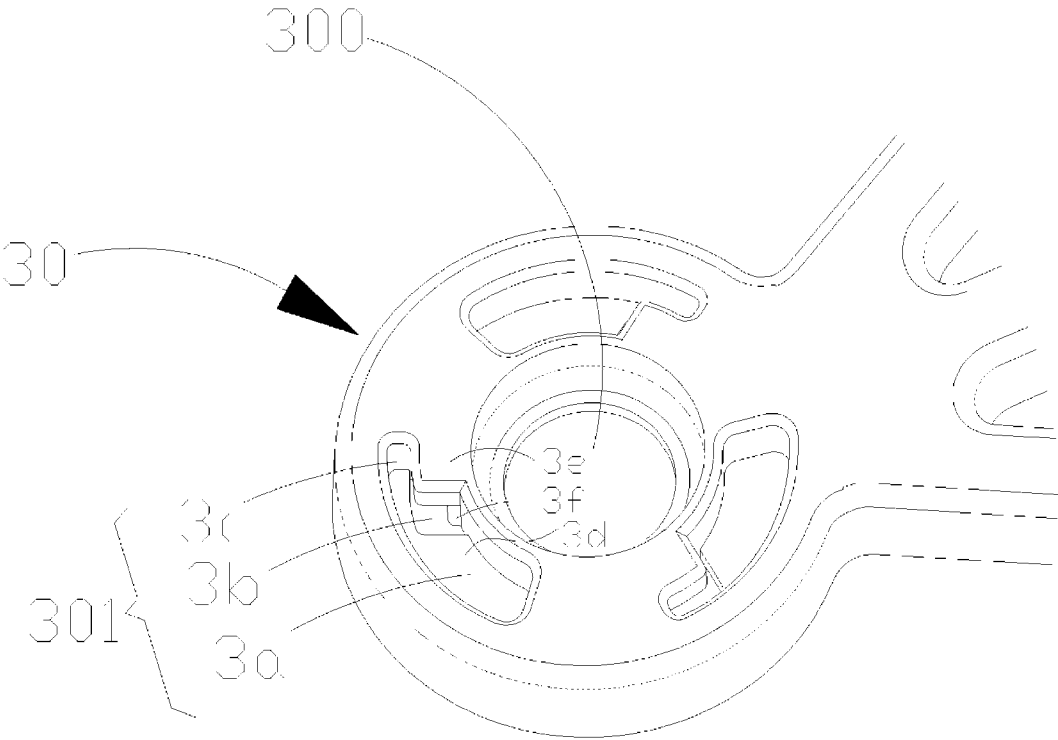


FIG. 6



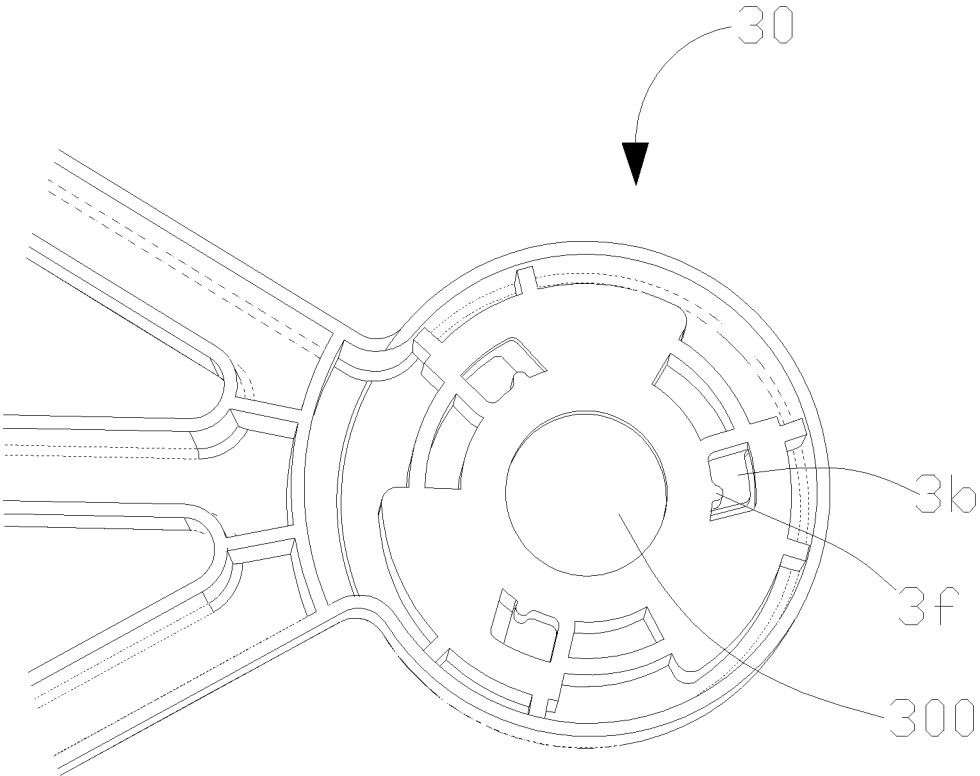


FIG. 7

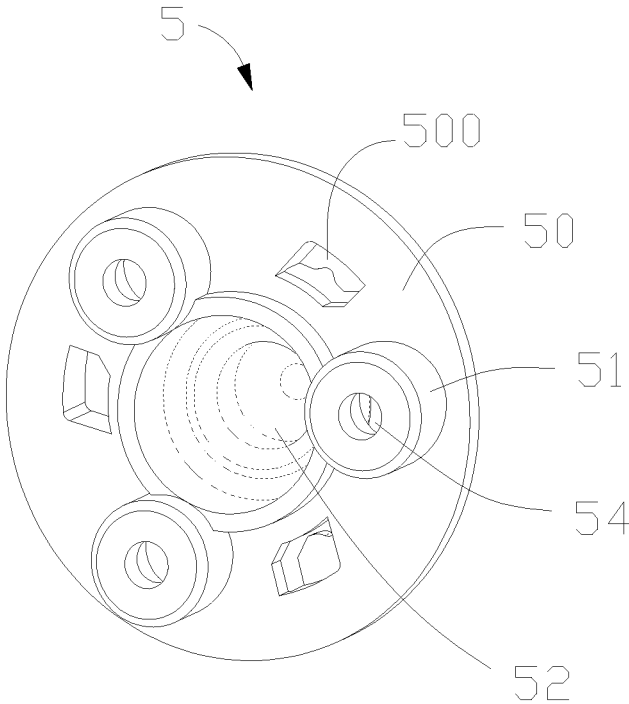


FIG. 8

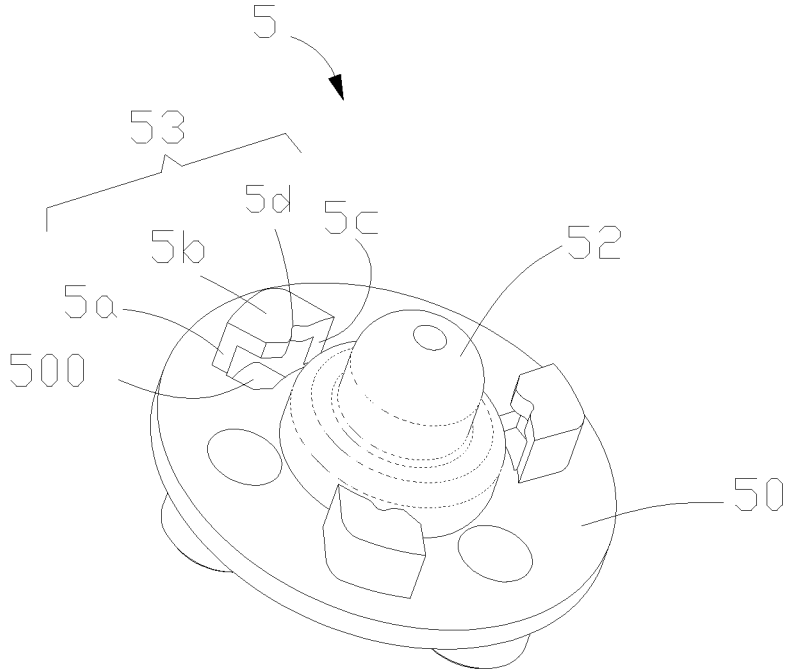


FIG. 9

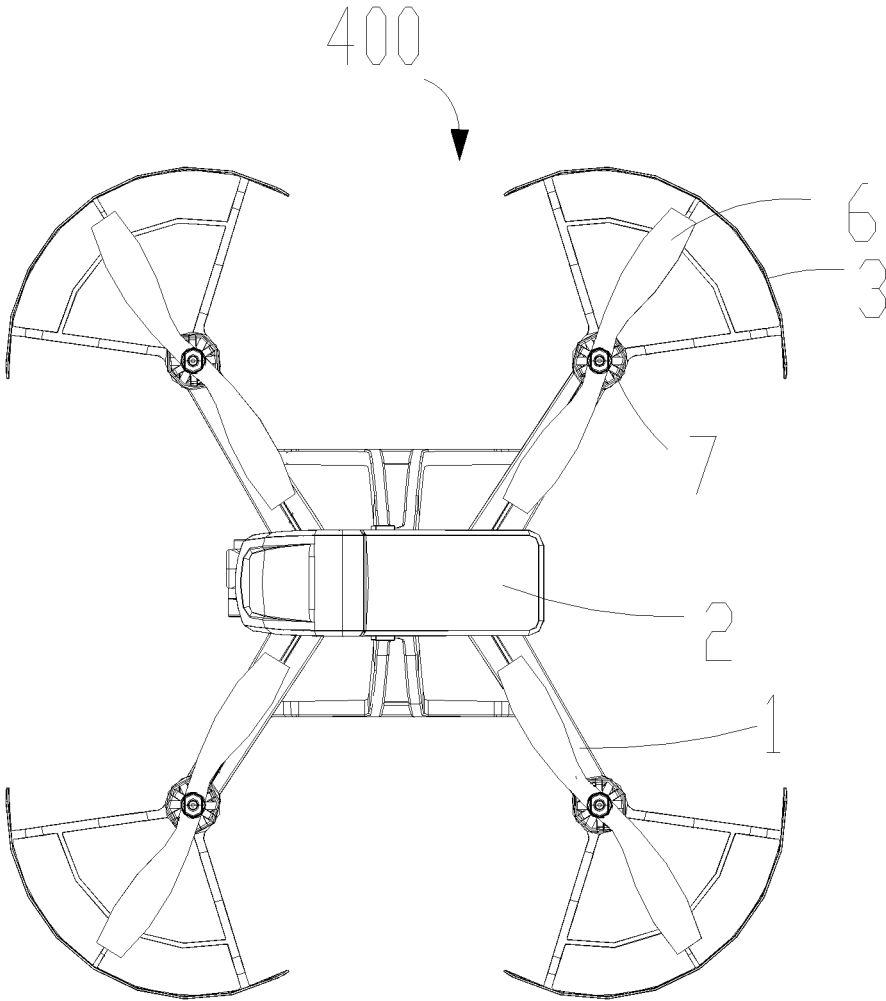


FIG. 10

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## ROTOR SHROUDING APPARATUS, SUPPORTING ASSEMBLY, AND UNMANNED AERIAL VEHICLE USING THE SAME

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims all benefits accruing under 35 U.S.C. § 119 from China Patent Applications No. 201520933286.9, filed on Nov. 20, 2015 and No. 201520932562.X, filed on Nov. 20, 2015 in the China Intellectual Property Office, the contents of which are hereby incorporated by reference.

### FIELD

The present disclosure relates to multi-rotor aerial vehicles, and more particularly to rotor shrouding apparatus, supporting assemblies, and unmanned aerial vehicles using the same.

### BACKGROUND

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot aboard. Small sized UAVs are increasingly used in various fields such as aerial photography, surveillance, scientific research, geological survey, and remote sensing. The UAVs include rotors or propellers generating thrust to control orientation and speed of the vehicle. Unprotected spinning blades of the rotors pose a safety risk to operator, and are likely to be damaged upon contact with an object. Shrouds may be provided in the UAVs to protect the rotors.

The UAVs are commonly disassembled in storage. To implement flight, and store the UAVs after the flight, users assemble and disassemble the UAVs with complicated and numerous separate parts, which are time consuming especially for untrained users.

### BRIEF DESCRIPTION OF THE DRAWINGS

Implementations are described by way of example only with reference to the attached figures.

FIG. 1 is an isometric view from a top side of one embodiment of a supporting assembly.

FIG. 2 is another isometric view from a bottom side of the supporting assembly of FIG. 1.

FIG. 3 is an exploded view from a top side of a partial of one embodiment of the supporting assembly.

FIG. 4 is another exploded view from a bottom side of the partial of the supporting assembly of FIG. 3.

FIG. 5 is an isometric view from a top side of one embodiment of a rotor shroud.

FIG. 6 is an enlarged isometric view of a circled portion A of FIG. 5.

FIG. 7 is an enlarged bottom view of the part of the rotor shroud of FIG. 6.

FIG. 8 is an isometric view from a top side of one embodiment of a shroud seat.

FIG. 9 is another isometric view from a bottom side of the shroud seat of FIG. 8.

FIG. 10 is a top view of one embodiment of an unmanned aerial vehicle.

### DETAILED DESCRIPTION

It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have

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been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein can be practiced without these specific details. In other instances, methods, procedures, and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

In the present disclosure, the terms “upper,” “lower,” “top,” “bottom,” “vertical,” “horizontal” and other similar direction-indicating terms are used with reference to the unmanned aerial vehicle (“UAV”) in its normal operational mode, and should not be considered limiting.

Referring to FIG. 1 and FIG. 2, one embodiment of a supporting assembly 100 of a UAV is disclosed. The supporting assembly 100 comprises a base 2, a plurality of rotor arms 1, and a plurality of rotor shrouds 3. Each rotor arm 1 comprises a proximal end and a distal end opposite to the proximal end. The rotor arms 1 are each secured to the base 2 at the proximal end, and extend out from the base 2 in different directions. The rotor shrouds 3 each comprise a converged end, an arc shaped end or outer frame 32, and one or more connecting members or struts 31 extending from the arc shaped end to the converged end. The converged end is coupled to the arc shaped end 32 opposite to the converged end by the one or more connecting members 31. The converged ends of the plurality of rotor shrouds 3 are removably secured to the distal ends of the plurality of rotor arms 1 in a one-to-one manner.

The base 2 is configured to carry a payload such as electrical components adapted to control various aspects of the operation of the UAV. The electrical components can comprise at least one of an energy source (e.g., battery), a flight control or navigation module, a GPS module (e.g., GPS receivers or transceivers), an inertial measurement unit (IMU) module, a communication module (e.g., wireless transceiver), and an electronic speed control (ESC) module adapted to control an actuator (e.g., electric motor). The payload can also include an application device such as a camera, video camera, or pesticide sprayer. A through hole can be defined on the base 2, so that the application device can extend from one top side of the base 2, through the through hole, and out to an opposite bottom side of the base 2. In one embodiment, the base 2 comprises a bottom board and side walls extending from edges of the bottom board. The bottom board and the sidewalls can cooperatively form an interior space. The shape of the bottom board is not limited and can be round, oval, triangle, square, rectangle, pentagon, or hexagon shaped.

The plurality of rotor arms 1 can be arranged symmetrically with respect to a center of the base 2 or an axis of the base 2. The plurality of rotor arms 1 can have the same length and extend to the same vertical height with respect to the base 2. The number of the rotor arms 1 can be three to six. In one embodiment, the supporting assembly 100 comprises four rotor arms 1 symmetrically extending from the base 2 in four different directions. The four rotor arms 1 can be respectively secured to the side walls of the base 2 and adjacent to the four corners of a rectangular shaped bottom board of the base 2. In another embodiment, the supporting

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assembly **100** comprises six rotor arms **1** symmetrically extending from the base **2** in six different directions.

The rotor arm **1** can define a wiring channel extending inside the rotor arm **1** from the proximal end to the distal end and communicate with the interior space of the base **2** through holes defined in the side walls of the base **2**. The wiring channel is adapted to accommodate electrical wiring running therethrough to connect a motor adjacent to the distal end with the electrical component carried on the base **2**. The rotor arm **1** comprises an arm body. In one embodiment, the arm body comprises two sloping roofs **12** joined at a top edge and sloping down and away from each other to define the wiring channel between the two sloping roofs **12**. The rotor arm **1** can further comprise one or more beams **10**. The one or more beams **10** can be substantially perpendicular to the extending direction of the arm body inside the wiring channel. In one embodiment, the one or more beams **10** support the two sloping roofs **12**. The beams **10** are configured for enhancing the strength of the rotor arm **1**, so as to increase reliability and lifespan. The beams **10** can be spaced from each other and located at different locations along a length or extending direction of the rotor arm **1**. The beam **10** can have a cutout at its middle portion spaced from the two slopping roofs **12**. The electrical wiring can run through the wiring channel below or through the cutout of the beam **10**. The plurality of rotor arms **1** can be integrally formed with the base **2** as one piece.

Referring to FIG. 3 and FIG. 4, the distal ends of the rotor arms **1** are configured for having rotor assemblies connected thereto in a one-to-one manner. Each rotor assembly comprises a rotor **6** and an actuator **7** to actuate the rotor **6**. In one example, the rotor **6** can be a propeller, and the actuator **7** can be an electric motor, which when operated, rotates the blades of the propeller. The supporting assembly **100** can further comprise a plurality of motor seats **4** secured to the distal ends of the plurality of rotor arms **1** in a one-to-one manner. The rotor assemblies can be mounted to the motor seats **4**. In some embodiments, a plurality of through holes extend through a Y-shaped groove in the motor seat **4** to receive means (e.g., screws) that fix the actuator **7** on a top of the motor seat **4**. In some other embodiments, the motor seat **4** can comprise a receptacle that is shaped and configured to receive a connector of the rotor assembly in order to fix the actuator **7** to the top of the motor seat **4**. The plurality of motor seats **4**, the plurality of rotor arms **1**, and the base **2** can be integrated together as one piece to minimize the number of components in the supporting assembly **100** and the UAV.

The distal ends of the rotor arms **1** are also configured for having rotor shrouds **3** coupled thereto in a one-to-one manner. The converged end of the plurality of rotor shrouds **3** can be removably engaged with and secured to the distal end of the plurality of rotor arms **1** through means, such as a snap-fit engagement, plug-in engagement, hooking engagement, socket-buckle engagement, or mating engagement. The rotor shrouds **3** can be swiftly assembled and disassembled by moving the rotor shrouds **3** with respect to the rotor arm **1**. In some embodiments, the supporting assembly **100** further comprises a plurality of shroud seats **5**, and the rotor shrouds **3** are removably engaged with and secured to the distal ends of the plurality of rotor arms **1** through the motor seats **4** and the shroud seats **5** in a one-to-one manner.

The rotor shroud **3** is configured for protecting the rotor **6** and comprises a protecting surface having a circular sector shape between the converged end and the arc shaped end **32**. A central angle of the circular sector shaped protecting

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surface can be in a range from about 60° to about 120°. The rotor shroud **3** can be assembled (e.g., secured) to the rotor arm **1** in a connected position and disassembled (e.g., removed) from the rotor arm **1** in a disconnected position. In the connected position, the protecting surface extends from the distal end of the rotor arm **1** and inclined upward with respect to the rotor arm **1**. A size (e.g., a distance between the converged end to the arc shaped end **32** along a direction parallel to a rotating surface of the rotor **6**) of the rotor shroud **3** can be larger than the radius of the rotor **6**, so that in the connected position, the arc shaped end **32** can extend radially past the rotor **6**. In the connected position, the arc shaped end **32** of the rotor shroud **3** can be spaced above (e.g., up to about 3 mm to about 5 mm) the rotor **6** mounted on the distal end of the rotor arm **1**.

Referring to FIG. 5, each rotor shroud **3** can comprise a locking member **30** located at the converged end of the rotor shroud **3** and a circular sector shaped shroud body **33**. The shroud body **33** defines the protecting surface, and includes the converged end connected to the locking member **30** and the arc shaped end **32**. The shroud body **33** and the locking member **30** can be integrated with each other as one piece.

The circular sector shaped shroud body **33** can be a frame structure comprising a converged end, an arc shaped outer frame **32**, and a plurality of protecting struts **31** extending radially from the converged end to the arc shape outer frame **32** to cooperatively define the circular sector shape. An angle between two outermost protecting struts **31** can be in a range from about 60° to about 120°. The plurality of protecting struts **31** can be located in the same plane. In one embodiment, the plurality of protecting struts **31** directly extend from the locking member **30**. The protecting struts **31** and the arc shaped outer frame **32** can be elongated members such as rods, sticks, canes, columns, bars, or the like. In one embodiment, the circular sector shaped shroud body **33** comprises three protecting struts **31** located in the same plane, with the first end of the protecting struts **31** secured to a same location of the locking member **30**, and the second end of the protecting struts **31** respectively secured to two ends and the middle of the arc shaped outer frame **32**.

Referring back to FIG. 3, the locking member **30** is configured to be removably mounted on the bottom of the motor seat **4** through means such as the shroud seat **5**. The rotor shroud **3** and the shroud seat **5** can be assembled together as a rotor shroud apparatus **200**. The shroud seat **5** can be removably engaged with and secured to the locking member **30** through means, such as snap-fit engagement, plug-in engagement, hooking engagement, socket-buckle engagement, or mating engagement. The means allows the rotor shroud **3** to be swiftly assembled to and disassembled from the shroud seat **5**. The assembly and disassembly can be performed by moving the rotor shrouds **3** with respect to the shroud seat **5**. The shroud seat **5** does not need to be removed or disassembled from the motor seat **4**.

Referring to FIG. 6 to FIG. 9, in one embodiment, the locking member **30** can comprise at least one socket **301**. The shroud seat **5** can comprise a seat base **50** and at least one buckle **53**. The seat base **50** can have a round disk shape having an upper surface and a lower surface. The at least one buckle **53** protrudes from the lower surface of the seat base **50**. The buckle **53** can be integrated with the seat base **50** as one piece. The socket **301** and the buckle **53** are shaped and configured to engage and be secured with each other to complete the rotor shroud apparatus **200**.

In one embodiment, the socket **301** defines a preplace hole **3a**, a locking hole **3b**, and a sliding channel **3c** communicating with the preplace hole **3a** and the locking hole **3b**. The

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preplace hole **3a** is defined on an upper surface of the locking member **30**, and is adapted to receive the buckle **53** in the disconnected position before completing the engagement. The socket **301** can further comprise a first board **3d** defining a bottom of the preplace hole **3a**. The locking hole **3b** is adapted to receive the buckle **53** in the connected position where the engagement of the socket **301** and the buckle **53** engage. The locking hole **3b** can be defined in the locking member **30**, or on a lower surface of the locking member **30**. The socket **301** can further comprise a second board **3e** defining a top of the locking hole **3b**. The sliding channel **3c** connects the preplace hole **3a** and the locking hole **3b**, and is adapted to allow the buckle **53** to slide from the preplace hole **3a** to the locking hole **3b**, so as to move the buckle **53** with respect to the socket **301** between the disconnected position and the connected position.

The buckle **53** comprises a sliding wall **5a** protruding from the lower surface of the seat base **50** and a locking board **5b** connected to the sliding wall **5a**. The locking board **5b** has a shape that is capable of engaging with the locking hole **3b**. The sliding wall **5a** has a shape that is capable of sliding in and engaging with the sliding channel **3c**. The locking board **5b** can be substantially parallel to the lower surface of the seat base **50**. The sliding wall **5a** can be substantially perpendicular to the lower surface of the seat base **50**. The sliding wall **5a** and the locking board **5b** are connected with each other at edges to form an “L” shaped structure. The sliding wall **5a** and the locking board **5b** can be integrated with each other as one piece. The sliding channel **3c** and the locking hole **3b** forms an “L” shaped space corresponding to the “L” shaped structure. In the connected position, the sliding wall **5a** is located in and engaged with the sliding channel **3c**, and the locking board **5b** is located in and engaged with the locking hole **3b**. The second board **3e** restricts the locking board **5b** from being movable along a vertical direction.

The buckle **53** can further comprise a blocking wall **5c** protruded from the lower surface of the seat base **50** and connect to both the sliding wall **5a** and the locking board **5b**. The sliding wall **5a**, the locking board **5b**, and the blocking wall **5c** can be integrated with each other as one piece. In the connected position, the blocking wall **5c** can be in contact with an edge of the first board **3d** and be prevented by the first board **3d** from being movable along a horizontal direction.

A through hole **500** can be defined on the seat base **50** above the locking board **5b**. The through hole **500** can provide a space for containing a portion of the second board **3e** during the sliding of the sliding wall **5a** into the sliding channel **3c** to facilitate assembly of the shroud seat **5** with the rotor shroud **3**.

The socket **301** can further comprise a protrusion or recess **3f** protruding towards or recessed from the locking hole **3b**, respectively, along a direction traversing a sliding direction of the buckle **53**. The locking board **5b** can define a recess or protrusion **5d** on a side of the locking board **5b**. The recess or protrusion **5d** is adapted to respectively engage with the protrusion or recess **3f** to further secure the locking board **5b** in the locking hole **3b**.

The socket **301** and the buckle **53** can be arc shaped and capable of engaging each other through a relative rotation between the socket **301** and the buckle **53** around a vertical axis. The arc shaped socket **301** and the arc shaped buckle **53** can be homocentric. The sliding channel **3c** and the sliding wall **5a** can be arc shaped and corresponded with each other (e.g., be homocentric), so that by rotating the locking member **30** relative to the shroud seat **5** around the

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vertical axis, the buckles **53** are capable of engaging with and releasing from the socket **301**. The locking member **30** can comprise a plurality of sockets **301**, and the shroud seat **5** can comprise a plurality of buckles **53** that are configured to engage with the plurality of sockets **301** in a one-to-one manner. The plurality of sockets **301** can be arranged around a first vertical axis of the locking member **30**. The first vertical axis can be located at the center of the arc shaped sockets **301**. The plurality of buckles **53** can be arranged around a second vertical axis of the shroud seat **5**. The second vertical axis can be located at the center of the arc shaped buckles **53**. The first and second vertical axes of the locking member **30** and the shroud seat **5** can be aligned with each other (e.g., to form a homocentric axis) during the assembling of the rotor shroud **3** with the shroud seat **5**. In one embodiment, the locking member **30** comprises three sockets **301** evenly disposed around the vertical axis by having an angle of about 120° therebetween. The shroud seat **5** comprises three buckles **53** evenly disposed around the vertical axis by having an angle of about 120° therebetween.

In assembling, the seat base **50** can be firstly fixed to the bottom of the motor seat **4**, and then the buckle **53** can be disposed in the preplace hole **3a**. By rotating the rotor shroud **3** relative to the seat base **50** around the homocentric axis, the sliding wall **5a** slides into the sliding channel **3c**, and the locking board **5b** slides into the locking hole **3b** and is secured by the locking hole **3b**. In disassembling, by rotating the rotor shroud **3** relative to the seat base **50** along a counter direction around the homocentric axis, the sliding wall **5a** slides out from the sliding channel **3c**, and the locking board **5b** can be released from the locking hole **3b**.

The locking member **30** can further define a lamp hole **300**, which can be a round through hole, at the vertical axis of the locking member **30**. The shroud seat **5** can further comprise a lampshade **52**, which is a housing member to accommodate a light source therein at the vertical axis of the shroud seat **5**. The lampshade **52** can protrude from the lower surface of the seat base **50**, and can have a dome shape that corresponds to the lamp hole **300**, and can be capable of being received by the lamp hole **300** from the upper side of the locking member **30**. In the connected position, the lampshade **52** is located in the lamp hole **300** and exposed from the lower side of the locking member **30**. Light can penetrate out from the lampshade **52** and facilitate a night flight of the UAV. A wiring of the light source can go through the wiring channel in the rotor arm **1** to reach the electrical components on the base **2**.

The plurality of shroud seats **5** are configured for removably securing the rotor shrouds **3** to a distal end of the rotor arm **1**, and especially to the motor seats **4**. The plurality of shroud seats **5** can be mounted on a bottom of the plurality of motor seats **4** in a one-to-one manner via fasteners such as screw, bolt, buckle, clamp, clasp, latch, hook, nail, pin strap, cable, or the like. The motor seat **4** can comprise a housing member, which can be a cylinder, having an opening towards the bottom side. The housing member defines a cavity to receive the shroud seat **5**. In one embodiment, the shroud seat **5** defines several screw holes **54** to receive means (e.g., fasteners or screws) for fixing the shroud seat **5** to the bottom of the motor seat **4**. The screws for fixing the shroud seat **5** can be the same screws for fixing the actuator, which go through the “Y” shaped through channel from the actuator to the shroud seat **5**. In one embodiment, the shroud seat **5** can comprise means, such as column protrusions **51** protruding from the upper surface of the seat base **50** to

secure the motor seat **4**. Each column protrusion **51** defines a screw hole **54** to receive the screw securing the shroud seat **5** to the motor seat **4**.

Referring to FIG. **10**, one embodiment of a UAV **400** comprises the supporting assembly **100**, a plurality of rotor assemblies mounted on the distal ends of the plurality of rotor arm **1** in a one-to-one manner, and the payload carried by the base **2**. Each rotor assembly comprises the rotor **6** (e.g., propeller) rotatably about a rotor axis and the actuator **7** (e.g., electric motor) to actuate blades or paddles of the rotor **6** such that the rotor **6** exerts an upward lift force on the rotor arm **1**.

The rotor assembly can be mounted on top of the motor seat **4**. The actuator **7** can be fixedly and removably mounted on the motor seat **4** via fasteners such as a screw, bolt, buckle, clamp, clasp, latch, hook, nail, pin strap, cable, or the like. The rotor **6** can be mounted on the motor seat **4** and rotatably about the rotor axis along a vertical direction.

The rotor shroud apparatus **200** surrounds the rotor **6** from outer and lower sides, preventing the rotor **6** from being damaged by contacting object, and protecting the operator from being hurt by the blades of the rotor **6**. The rotor shroud **3** and the rotor shroud apparatus **200** can be easily assembled and disassembled to save time. The rotor shroud apparatus **200**, supporting assembly **100**, and UAV **400** are simplified in designs, which can be easily manufactured and light in weight.

The embodiments shown and described above are only examples. Even though numerous characteristics and advantages of the present technology have been set forth in the foregoing description, together with details of the structure and function of the present disclosure, the disclosure is illustrative only, and changes may be made in the detail, especially in matters of shape, size, and arrangement of the parts within the principles of the present disclosure, up to and including the full extent established by the broad general meaning of the terms used in the claims. It will therefore be appreciated that the embodiments described above may be modified within the scope of the claims.

What is claimed is:

**1.** A supporting assembly for an unmanned aerial vehicle, the supporting assembly comprising:

a base;

a plurality of rotor arms extending from the base, each of the plurality of rotor arms comprising a proximal end secured to the base and a distal end opposite to the proximal end;

a plurality of motor seats secured to the distal ends of the plurality of rotor arms in a one-to-one manner;

a plurality of rotor shrouds, each of the plurality of rotor shrouds comprising a converged end, an arc shaped end, and a locking member at the converged end, the converged end being removably engaged with and secured to the distal end of the rotor arm by rotating the each of the plurality of rotor shrouds with respect to the rotor arm around a vertical axis;

a plurality of shroud seats being configured to be mounted to the plurality of motor seats in a one-to-one manner; wherein the locking members of the plurality of rotor shrouds are configured to secure the plurality of rotor shrouds to the plurality of shroud seats in a one-to-one manner through a removable engagement.

**2.** The supporting assembly of claim **1**, wherein the removable engagement is a snap-fit engagement, plug-in engagement, hooking engagement, socket-buckle engagement, or mating engagement.

**3.** The supporting assembly of claim **1**, wherein the rotor shrouds each comprises a protecting surface having a circular sector shape defined between the converged end and the arc shaped end, and the protecting surface is inclined upward with respect to the rotor arms.

**4.** The supporting assembly of claim **3**, wherein a central angle of the circular sector shaped protecting surface is in a range from about 60° to about 120°.

**5.** The supporting assembly of claim **1**, wherein the each of the plurality of rotor shrouds comprises one or more connecting members extending from the arc shaped end to the converged end, the one or more connecting members are a plurality of protecting struts extending radially from the converged end to the arc shaped end.

**6.** The supporting assembly of claim **1**, wherein the shroud seats each comprises a seat base and one or more buckles protruding from a surface of the seat base, the locking member of the rotor shroud further comprises one or more sockets, the one or more buckles engaging a corresponding socket to removably secure the rotor shroud to the shroud seat.

**7.** The supporting assembly of claim **6**, wherein the socket defines a preplace hole, a locking hole, and a sliding channel communicating with both the preplace hole and the locking hole; the buckle comprises a sliding wall protruding from the surface of the seat base and a locking board connected to the sliding wall; the preplace hole is capable of receiving the buckle; the sliding wall is capable of being located in and engaged with the sliding channel; and the locking board is capable of being located in and engaged with the locking hole.

**8.** The supporting assembly of claim **7**, wherein the buckle comprises a blocking wall protruding from the surface of the seat base and connected to both the sliding wall and the locking board.

**9.** The supporting assembly of claim **7**, wherein the seat base defines a through hole above the locking board.

**10.** The supporting assembly of claim **6**, wherein the socket and the buckle are arc shaped, and are capable of engaging with each other through a relative rotation between the socket and the buckle around the vertical axis.

**11.** The supporting assembly of claim **1**, wherein the locking member comprises a plurality of sockets arranged around the vertical axis; the plurality of shroud seats each comprises a seat base and a plurality of buckles protruding from a surface of the seat base and arranged around the vertical axis; the plurality of sockets and the plurality of buckles are arc shaped and configured for engaging with each other in a one-to-one manner.

**12.** The supporting assembly of claim **1**, wherein the locking member defines a lamp hole, the shroud seat comprises a lampshade, and the lampshade is received in the lamp hole.

**13.** The supporting assembly of claim **1**, wherein each of the plurality of motor seats comprises a housing member defining a cavity to receive each of the plurality of shroud seats.

**14.** The supporting assembly of claim **1**, wherein each of the plurality of shroud seats comprises a plurality of column protrusions, and the plurality of column protrusions define screw holes to receive screws securing the plurality of shroud seats to the plurality of motor seats.

**15.** The supporting assembly of claim **1**, wherein the rotor arm comprises an arm body and at least one beam supporting the arm body, the at least one beam is substantially perpendicular to the arm body.



16. The supporting assembly of claim 1, wherein the plurality of motor seats is configured to have both the plurality of shroud seats and a plurality of rotor assemblies mounted thereon in a one-to-one manner.

17. An unmanned aerial vehicle comprising:

a supporting assembly comprising:

a base;

a plurality of rotor arms extending from the base, and each of the plurality of rotor arms comprising a proximal end secured to the base and a distal end opposite to the proximal end; and

a plurality of rotor shrouds, each of the plurality of rotor shrouds comprising a converged end removably engaged with and secured to the distal end of the rotor arm by rotating the each of the plurality of rotor shrouds with respect to the rotor arm around a vertical axis, an arc shaped end opposite to the converged end, and one or more connecting members extending from the arc shaped end to the converged end; and

a plurality of rotor assemblies mounted on the distal ends of the plurality of rotor arms in a one-to-one manner, each of the plurality of rotor assemblies comprising a rotor and an actuator.

18. The unmanned aerial vehicle of claim 17, wherein the supporting assembly further comprises a plurality of shroud

seats and a plurality of motor seats, the plurality of motor seats are secured to the distal end of the plurality of rotor arms, and both the plurality of shroud seats and the plurality of rotor assemblies are mounted on the plurality of motor seats in a one-to-one manner, the plurality of rotor shrouds are removably mounted on the plurality of motor seats through the plurality of shroud seats in a one-to-one manner.

19. A rotor shroud apparatus comprising:

a rotor shroud comprising a locking member and a shroud body, the shroud body having a converged end and an arc shaped end opposite to the converged end, the locking member being connected to the shroud body at the converged end, and the shroud body and the locking member are integrated with each other as one piece; and

a shroud seat being configured to be mounted to a motor seat secured to a distal end of a rotor arm of an unmanned aerial vehicle and the rotor shroud

wherein the locking member of the rotor shroud is removably engaged with and secured to the distal end of the rotor arm through the shroud seat by rotating the rotor shroud with respect to the rotor arm around a vertical axis.

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