

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SZ DJI TECHNOLOGY CO., LTD.,

Petitioner,

v.

AUTEL ROBOTICS USA LLC,

Patent Owner.

IPR2019-00846

U.S. Patent No. 9,260,184

**DECLARATION OF DR. AFRED DUCHARME,
UNDER 37 C.F.R. § 1.68 IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW**

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I. INTRODUCTION

1. I, Alfred Ducharme, have been retained by counsel for SZ DJI Technology Co., Ltd. (“DJI” or “Petitioner”) as a technical expert in connection with the proceeding identified above. I submit this declaration in support of DJI’s Petition for *Inter Partes* Review of claims 3 and 4 U.S. Patent No. 9,260,184 (“the ’184 patent”).

2. I am being compensated for my work in this matter at an hourly rate. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this matter. My compensation is not contingent on the outcome of this matter or the specifics of my testimony. I have no personal or financial stake or interest in the outcome of the present proceeding.

3. In the preparation of this declaration, I have studied at least:

- (1) The ’184 patent, DJI-1001;
- (2) The prosecution history of the ’184 patent, DJI-1002;
- (3) English language translation of JP Unexamined Utility Model Application Publication H06-17511 to Ryoichi Sasaki (“Sasaki”; DJI-1006);
- (4) U.S. Patent No. 5,133,617 to Sokn (“Sokn”; DJI-1007);
- (5) U.S. Patent No. 8,052,081 to Olm (“the ’081 patent”; DJI-1008);
- (6) “Design and Construction of a Quadrotor-type Unmanned Aerial

- Vehicle: Preliminary Results” by Sa (“Sa”; DJI-1009);
- (7) Design of a Four Rotor Hovering Vehicle (“Nice”; DJI-1010)
 - (8) The JAviator Quadrotor – An Aerial Software Testbed (“Trummer”; DJI-1011);
 - (9) U.S. Patent No. 135,655 (“the ’655 patent”; DJI-1012);
 - (10) U.S. Patent No. 821,534 to Perkins (“Perkins”; DJI-1013);
 - (11) Contra Rotating Propeller Drive System User Guide (“Contra”; DJI-1014);
 - (12) KitchenAid Hand Mixer Instructions (DJI-1015);
 - (13) User Manual for the Microdrones md4-200, Version 2.2 (“Microdrone”; DJI-1016);
 - (14) U.S. Patent No. 2,470,517 to Obrist (“Obrist”; DJI-1017);
 - (15) European Patent Application EP 0 921 067 to Peter Muller (“EP067”; DJI-1018); and
 - (16) Patent Owner Preliminary Response in IPR2019-00343 (DJI-1019).

My own knowledge and experience based upon my work in the field of semiconductor electronics and any other documents I cite in this declaration.

II. QUALIFICATIONS

4. My qualifications and professional experience are described in my *Curriculum Vitae*, a copy of which can be found at DJI-1004. The following is a brief summary of my relevant qualifications and professional experience.

5. I earned a B.S. degree in Electrical Engineering in 1990 from the University of Massachusetts. I then earned my M.S. degree in 1992 from the University of Central Florida. I also earned my Ph.D. degree in Electrical Engineering from the University of Central Florida in 1994

6. From 2002 to 2013, I served as an Associate Professor of Engineering at the University of Central Florida, as Assistant Dean for the College of Engineering and Computer Science, and as Chairman for the Department of Engineering Technology for the College of Engineering and Computer Science. I completed my doctoral degree in Electrical Engineering with a specialization in Photonics, which is the study of the generation, manipulation and detection of light. I created the University of Central Florida's undergraduate degree program in Photonics, and I have taught a variety of university level courses in photonics, electronics, mechanics, and robotics.

7. Before joining the University of Central Florida, I was an engineer in the optical industry for eight years and worked for three high technology companies. I am an inventor listed in the following twenty-three United States patents: 8,142,051, 7,959,320, 7,659,674, 7,572,028, 7,520,634, 7,387,405, 7,350,936, 7,255,457, 7,242,152, 7,186,003, 7,161,556, 7,135,824, 7,132,785, 7,088,040, 7,064,498, 7,014,336, 6,975,079, 6,956,500, 6,897,624, 6,608,453, 6,100,540, 6,049,297, 5,997,155. A listing of the year, patent number, and patent

title is included in my curriculum vitae. I am also a listed inventor on several international patents.

8. In addition to my electrical engineering experience, I have been deeply involved in the design of mechanical and aesthetic features of a variety of products, specifically of Unmanned Aerial Vehicles (“UAV”) and drones. In 2010, I and other co-founders, Daniel Burroughs and Stacey Ducharme, founded Hoverfly Technologies, Inc. (“Hoverfly”), a self-funded startup. Hoverfly currently develops and manufactures aerial drone systems for commercial and industrial use. These systems include multi-rotor aerial vehicles, flight controllers, and camera gimbal stabilizers for recording in-flight video. Around September 2011, Hoverfly launched a commercial multi-rotor flight controller, a first of its kind at the time.

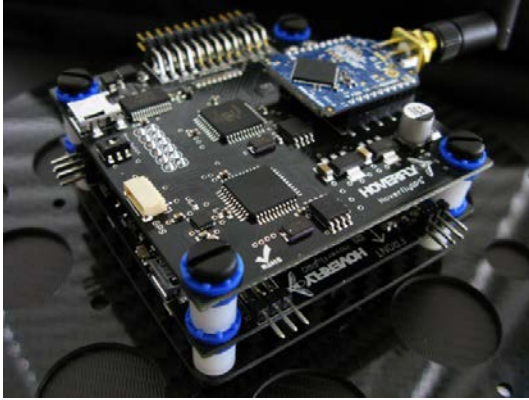
9. As part of my past and ongoing experience at Hoverfly, I have experience with the design and fabrication of UAVs, including the design and fabrication of UAV control systems. The UAV products designed, fabricated, and sold by Hoverfly are mechanical in nature and have many mechanical components. As part of my work for Hoverfly, I developed a deep understanding of which mechanical components and component designs were suitable for UAVs, the mechanical design and engineering principles that control the design and build of UAV components, and how to design and produce components that would

withstand environmental conditions and operational stresses and result in optimal flying performance.

10. At Hoverfly, I have managed a team of engineers in designing at least twenty (20) products. The development of these products has included mechanical, electrical, and aesthetic considerations. To provide just a few examples, our team's—and my—work includes the design and production of the: shape of landing gear and arms, main body, canopy, and power systems. In addition, I am experienced with Computer Aided Design (CAD) software and have designed hundreds of mechanical parts used in our products.

11. A few photographs of Hoverfly products of which I have been involved in the design and manufacturing of are reproduced below:





12. It is for at least these reasons that I am an expert in UAVs, including the design of mechanical, electrical, and power related components and of software used for flight control, navigation, and obstacle detection and avoidance.

13. Additional information regarding my background, qualifications, and presentations is included as part of my *curriculum vitae* (“CV”), which is provided as DJI-1004.

III. RELEVANT LEGAL STANDARDS

14. I have been asked to provide my opinions regarding the patentability of claims 3 and 4 (the “Challenged Claims”) of the ’184 patent based on the references discussed herein.

15. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the ’184 patent, I am relying on certain legal principles that counsel has explained to me.

16. I have been instructed as to the definition of “anticipation” in the context of the patent laws. I understand that for a claim to be invalid as anticipated, all of the requirements of that claim must be present in a single previous device or method that was known of, used, or described in a single previous printed publication or patent. To anticipate the invention, the prior art does not have to use the same words as the claim, but all of the requirements of the claim must have been disclosed, either stated expressly or implied to a person having ordinary skill in the art in the technology of the invention, so that looking at that one reference, that person could make and use the claimed invention.

17. I have been instructed as to the definition of “obviousness” in the context of the patent laws.

18. It is my understanding that even though an invention may not have been identically disclosed or described before it was made by an inventor, in order

to be patentable, the invention must also not have been obvious to a person having ordinary skill in the art (“POSITA”) before the effective filing date of the patent (which in these proceedings I am assuming to be May 15, 2013).

19. I understand that obviousness is a question of law based on underlying factual issues including the level of ordinary skill in the art at the time of the patent’s effective filing date, the scope and content of the prior art, and any differences between the prior art and the claimed invention.

20. I understand that the scope and content of prior art for deciding whether the invention was obvious includes at least prior art in the same field as the claimed invention. It also includes prior art from different fields that a POSITA would have considered when trying to solve the problem that is addressed by the invention.

21. I understand that the existence of each and every element of the claimed invention in the prior art does not necessarily prove obviousness. Most, if not all, inventions rely on building blocks of prior art. But, in considering whether a claimed invention is obvious, I understand that one may find obviousness if, at the time of the patent’s effective filing date, there was a reason that would have prompted a POSITA to combine the known elements in a way the claimed invention does, taking into account such factors as (1) whether the claimed invention was merely the predictable result of using prior art elements according to

their known function(s); (2) whether the claimed invention provides an obvious solution to a known problem in the relevant field; (3) whether the prior art teaches or suggests the desirability of combining elements claimed in the invention; (4) whether the prior art teaches away from combining elements in the claimed invention; (5) whether it would have been obvious to try the combinations of elements, such as when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions; and (6) whether the change resulted more from design incentives or other market forces.

22. To find that the prior art renders the invention obvious, I understand that one must find that the prior art provided a reasonable expectation of success and that “obvious to try” is not sufficient in unpredictable technologies. I also understand that it is impermissible to find obviousness based on hindsight reasoning, and must be found only by considering what was known at the time of the patent’s effective filing date.

IV. THE ’184 PATENT

23. The ’184 patent was filed on May 14, 2014 and claims priority benefit to a Canadian application, CA 2815885 which I refer to as the “earliest possible priority date of the ’184 patent.” The ’184 patent includes a single independent claim (claim 1). As I set forth below, claim 1 includes three categories of limitations: basic structural components of the UAV, operation of the propulsion

system, and a coupling mechanism for the propellers. For ease of discussion, I have associated reference labels with each claim limitation.

Basic Structure of the UAV

- [1A] a body;
- [1B.1] a plurality of arms extending laterally from the body, and
- [1B.2] a rotor assembly attached to an outside end of each arm;
- [1C] each rotor assembly comprising [1C.1] a rotor blade releasably attached to [1C.2] a driveshaft by [1C.3] a lock mechanism, and
- [1C.4] a drive rotating the driveshaft

Operation of the Propulsion System

- [1D] wherein a first driveshaft rotates in a clockwise direction and a second driveshaft rotates in a counterclockwise direction;

Coupling Mechanism

- [1E.1] wherein a clockwise rotor blade is releasably attached to the first driveshaft by engagement in a clockwise lock mechanism and [1E.2] generates a vertical lift force when rotated in the clockwise direction, and
- [1F.1] a counterclockwise rotor blade is releasably attached to the second driveshaft by engagement in a counterclockwise lock mechanism and [1F.2] generates a vertical lift force when rotated in the counterclockwise direction;
- [1G] wherein the clockwise rotor blade is engageable only with the clockwise lock mechanism and cannot be engaged in the counterclockwise lock mechanism, and

[1H] the counterclockwise rotor blade is engageable only with the counterclockwise lock mechanism and cannot be engaged in the clockwise lock mechanism; and

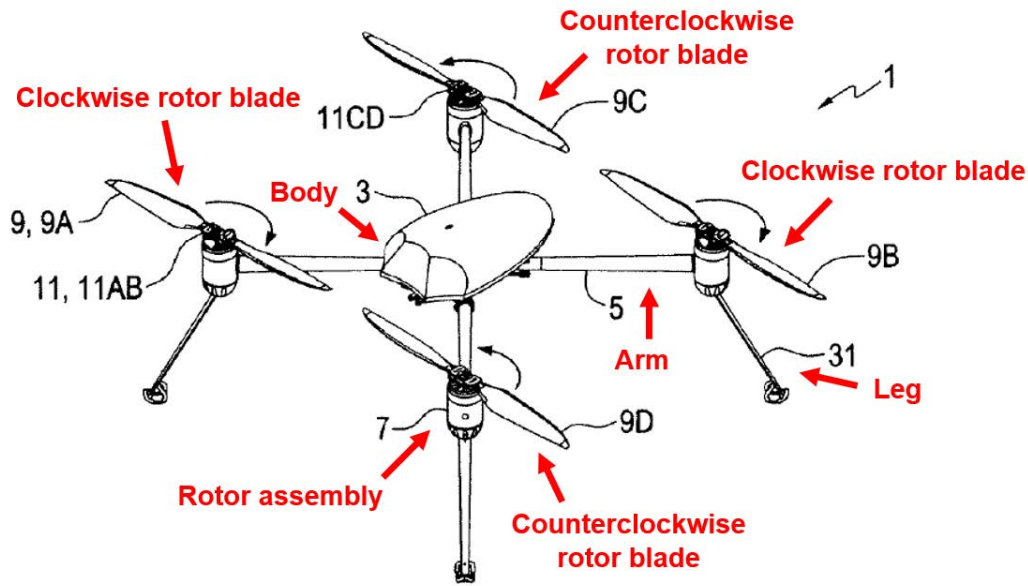
[1I] wherein the clockwise lock mechanism comprises a shaft lock portion attached to the first driveshaft and a blade lock portion attached to the clockwise rotor blade, the shaft lock portion defining notches configured to engage corresponding lugs on the blade lock portion.

24. Each of these three categories of components was well-known prior to the filing date of the '184 patent as I discuss in further in the sections that follow. Below, I discuss the limited disclosure in the '184 patent of these claimed components.

A. Basic Structural Components of the UAV and Propulsion System

25. The '184 patent “relates to the field of unmanned rotary aircraft or helicopters and more particularly rotary aircraft with a compact storage configuration.” (DJI-1001, 1:9-11.) Figure 1 of the '184 patent illustrates “a schematic perspective view of an embodiment of a rotary wing aircraft apparatus of the present disclosure with arms and legs in the operating position, and rotor blades installed.” (DJI-1001, 2:31-34.) I have provided Figure 1 below with annotations highlighting components¹.

¹ All coloring and annotations are added unless otherwise noted.



'184 Patent, Figure 1 (annotated)

26. The apparatus 1 illustrated in Figure 1 includes a body 3 and a plurality of arms 5 extending laterally from the body. (DJI-1001, 3:15-17.) A rotor assembly 7 having a rotor blade 9 releasably attached to a driveshaft by a lock mechanism 11, and a drive, typically an electric motor, rotating the driveshaft is attached to an outside end of each arm 5. (DJI-1001, 3:15-21.) A rotor assembly is also referred to in the art as a propulsion system or propulsion assembly. The illustrated apparatus 1 has four arms 5 and corresponding assemblies 7. (DJI-1001, 3:31-32.) Such an apparatus is also referred to as an unmanned aerial vehicle (UAV) or a quadcopter. In the UAV, “two of the rotor blades 9A, 9B rotate in a clockwise direction and generate a vertical lift force when rotated in the clockwise direction, while the other

two rotor blades 9C, 9D rotate in a counterclockwise direction and generate a vertical lift force when rotated in the clockwise direction.” (DJI-1001, 3:32-37.)

27. The '184 patent admits that the basic structural components were known, explaining that “[o]ne popular configuration [of rotary aircraft] includes a number of arms extending laterally from the aircraft body, with a rotor assembly on the end of each arm.” (DJI-1001, 1:18-20.) As I discuss in the next section, these basic structural components were not just well-known as the '184 patent acknowledges, they were on sale, in use, and in development by universities and other research institutions.

28. The '184 patent also admits that the operation of the propulsion system was known stating: “[A]s is known in the art, two of the rotor blades 9A, 9B rotate in a clockwise direction and generate a vertical lift force when rotated in the clockwise direction, while the other two rotor blades 9C, 9D rotate in a counterclockwise direction and generate a vertical lift force when rotated in the clockwise direction.” (DJI-1001, 3:32-37 (emphasis added).) I discuss in the next section it was indeed “known in the art,” and was also a common configuration in existing and experimental quadcopters, to have two of the four rotor blades rotate clockwise and the other two rotate counterclockwise to generate lift, equally divide the torque force, and maintain stability.

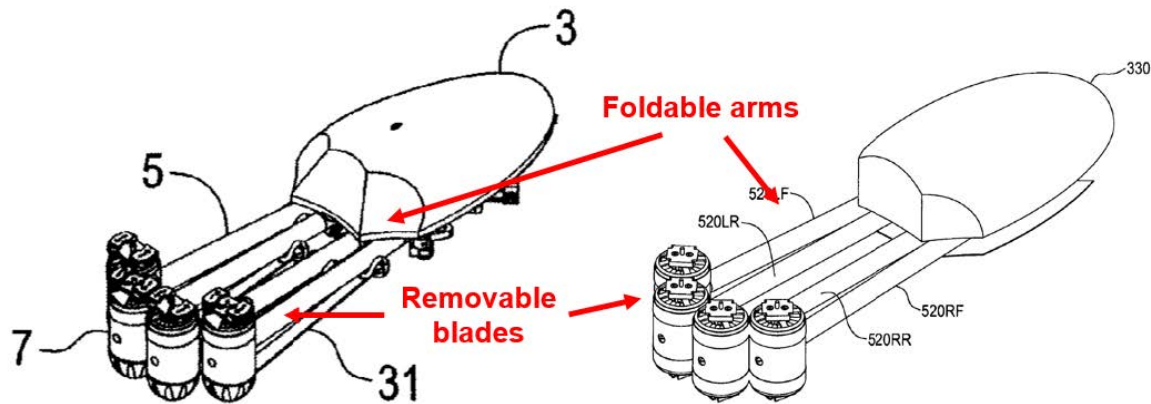
B. Coupling Mechanism

29. I note that the coupling limitations of claim 1 that I reproduced above are lengthy. However, these limitations require that the coupling between the rotor blade and driveshaft have two characteristics. First, the claim requires the coupling be “keyed” such that *“the clockwise rotor blade is engageable only with the clockwise lock mechanism and cannot be engaged in the counterclockwise lock mechanism, and the counterclockwise rotor blade is engageable only with the counterclockwise lock mechanism and cannot be engaged in the clockwise lock mechanism”* [1G]/[1H]. Second, the claim requires a lug and notch style coupling for at least the clockwise mechanism: *“the shaft lock portion defining notches configured to engage corresponding lugs on the blade lock portion.”* As I detail in the next section, lug and notch style coupling mechanisms have been used for centuries (if not longer) to couple two components together. Below, I discuss the short disclosure of the ’184 patent related to the coupling mechanism.

30. Dependent claims 3 and 4 add a directional twist-lock requirement to each of the couplings—namely that one component (the blade lock portion) be rotated (or twisted) in a specific direction to effectuate the coupling: *“blade lock portion of the clockwise lock mechanism is rotated counterclockwise with respect to the shaft lock portion thereof to releasably attach the clockwise rotor blade to the first driveshaft”* (claim 3) and *“blade lock portion of the counterclockwise lock*

mechanism is rotated clockwise with respect to the shaft lock portion thereof to releasably attach the counterclockwise rotor blade to the second driveshaft” (claim 4). As I detail in the next section, twist-lock connectors were also known and widely used prior to the filing date of the ’184 patent. The claimed directionality of the coupling was also known and in-use, particularly for coupling a component such as a blade to a rotating component (*e.g.*, a rotor).

31. The ’184 patent acknowledges that attachable and detachable propellers were known. (DJI-1001, 1:43-46.) U.S. Patent No. 8,052,081 to Olm (DJI-1008) (“the ’081 patent”) discloses one type of mechanism to couple a propeller to the driveshaft. I understand that the ’081 patent has the same named inventors as the ’184 patent, but that it is prior art to the ’184 patent because it was filed and issued before the earliest possible priority date of the ’184 patent. As can be seen below in Figure 3 of the ’184 patent and Figure 14 of the ’081 patent, the quadcopter of the ’184 patent and the quadcopter of the ’081 patent both have removable propellers (also referred to as rotor blades or blades) and foldable arms.

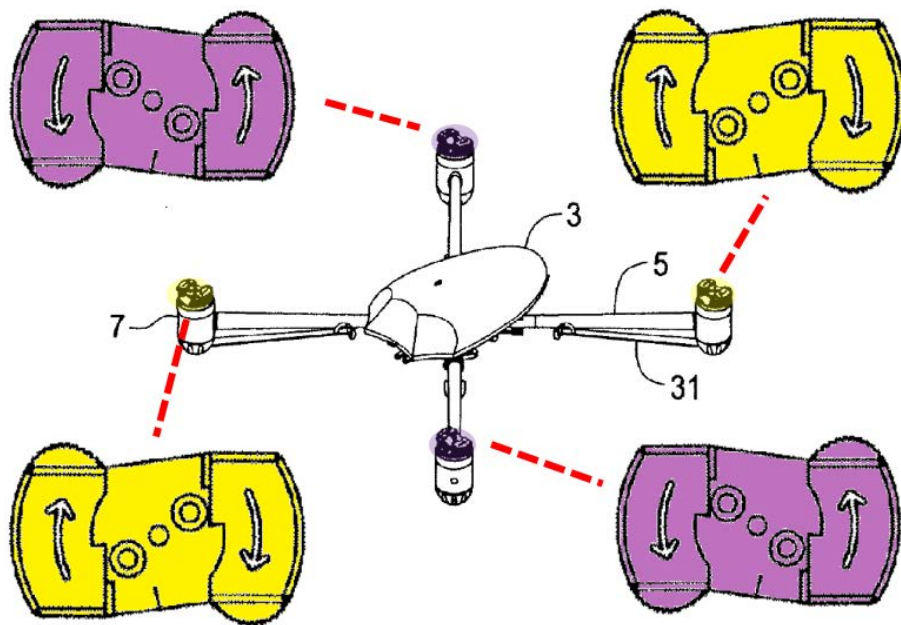


'184 Patent; Figure 3

'081 Patent, Figure 14

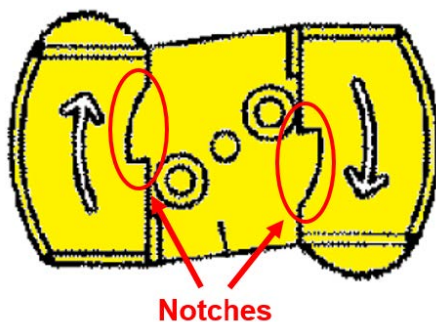
32. The '184 patent refers to the mechanism for coupling a propeller (rotor blade) as a “lock mechanism.” The '184 patent describes the “lock mechanism” as having a “shaft lock portion” attached to the driveshaft and a “blade lock portion” attached to the rotor blade.

33. I will first discuss the shaft lock portion. In the disclosed rotary aircraft of the '184 patent, as shown below, each clockwise-rotating driveshaft has a shaft lock portion (yellow), and each counterclockwise-rotating driveshaft has an oppositely configured shaft lock portion (purple) as illustrated in the Figure below. In this figure, I have cropped and combined images from Figure 2 and 6 of the '184 patent. The image of clockwise shaft lock portion (yellow) generated by mirroring counterclockwise shaft lock portion shown in Figure 6 (purple).

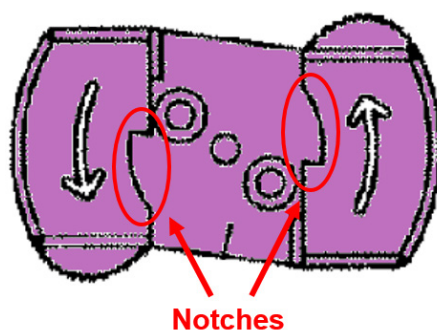


'184 Patent, Figures 2 and 6 (annotated and modified)

Each shaft lock portion is described as having “notches” and each blade lock portion as having “lugs.” The “notches” on the shaft lock portions are designed to receive the projections or “lugs” on the blade lock portions of the rotor blades, as shown in the Figures below. These figures depict images from Figure 6 of the '184 patent, with the mirror image of counterclockwise shaft lock portion depicted.



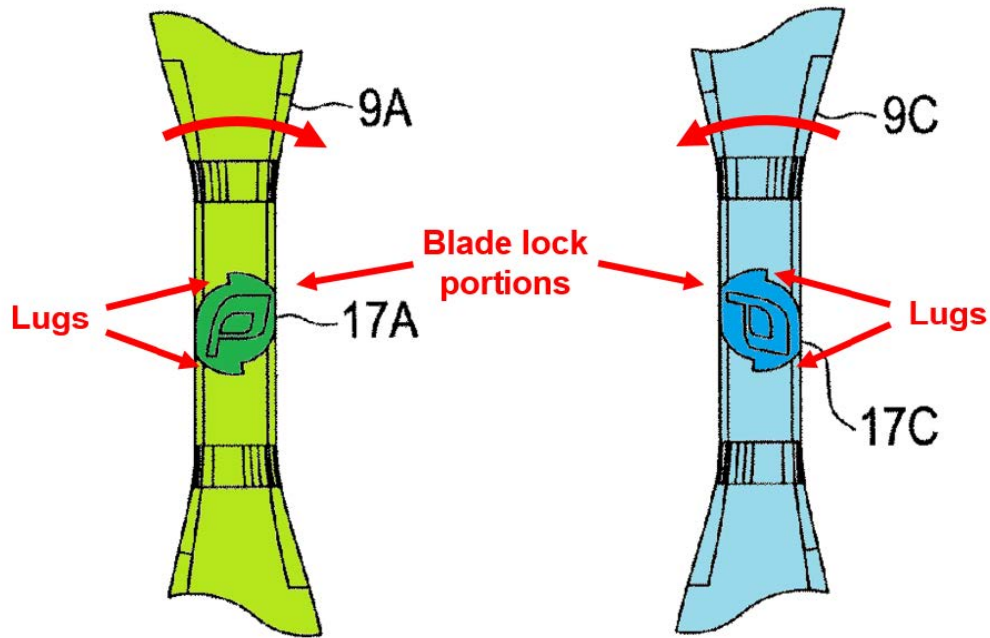
Clockwise Shaft Lock Portion



Counterclockwise Shaft Lock Portion

34. As can be seen above, each shaft lock portion has a center recess—in the middle, between the notches—into which the blade lock portion of the rotor blade may be inserted or “dropped” for attachment. (See DJI-1001, Figure 6 (showing recess 21 in counterclockwise shaft lock portion).) Because the clockwise shaft lock portion has notches that are configured differently from the notches on the counterclockwise shaft lock portion, the notches of the clockwise shaft lock portion will not “engage” the lugs on a rotor blade that is configured to engage the notches on the counterclockwise shaft lock portion, and vice versa.

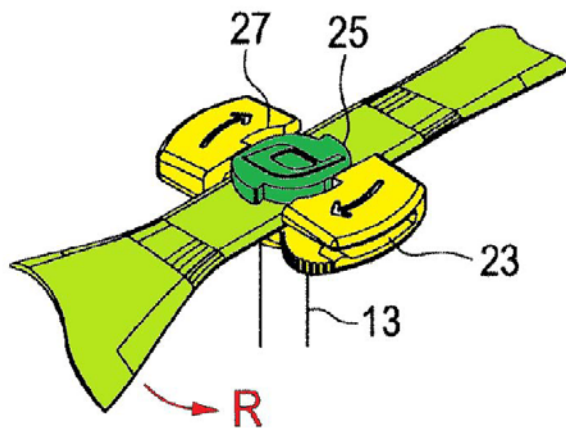
35. The lugs of the clockwise and counterclockwise rotor blades of the ’184 patent are shown in Figure 6 below edits such that portions of image are cropped and rearranged. The clockwise rotor blade (9A, light green, below) includes lugs on a blade lock portion (17A, dark green, below) that are specifically configured to engage the clockwise shaft lock portions (yellow, above), and that the counterclockwise rotor blade (9C, light blue, below) includes lugs on a blade lock portion (17C, dark blue, below) specifically configured to engage the counterclockwise shaft lock portions (purple, above). (See, *e.g.*, DJI-1001, 4:19-23.)



Clockwise Rotor Blade

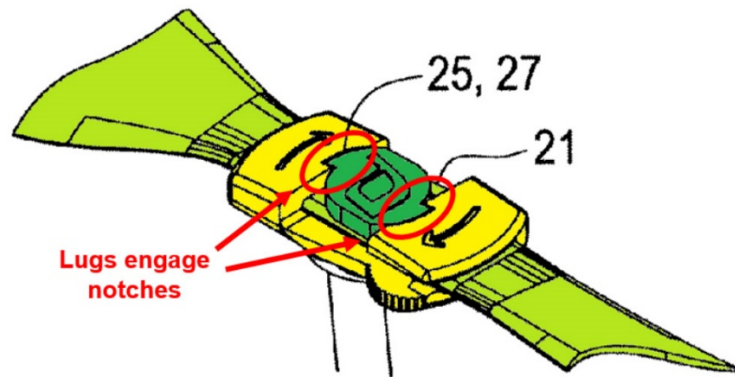
Counterclockwise Rotor Blade

36. To attach the clockwise rotor blade, the blade lock portion (dark green) of the clockwise rotor blade (light green) is inserted into and positioned in the recess of the shaft lock portion (yellow) of the clockwise lock mechanism. This is confirmed by annotated Figure 4 below. (See, *e.g.*, DJI-1001, 4:1-4.)



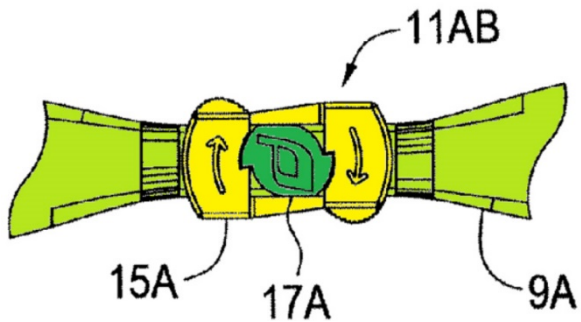
'184 Patent, Figure 4

To complete the installation, the clockwise rotor blade (light green) is rotated as indicated by red-highlighted “R” and arrow in Figure 4, above. As shown in annotated Figure 5 below, the rotor blade rotation causes the lugs (25) of the blade lock portion to engage the notches (27) of the shaft lock portion, and the rotor blade to slide into slots (23) on each side of the shaft lock portion. (See, *e.g.*, DJI-1001, 4:3-8.)

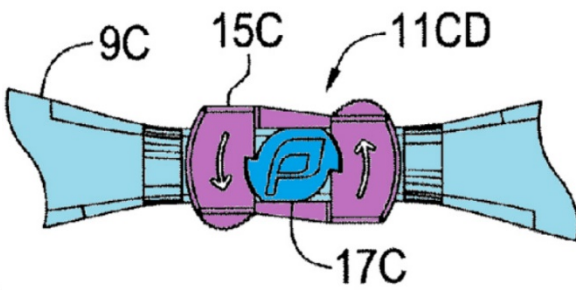


'184 Patent, Figure 5

37. Annotated Figures 7 and 10 below show the clockwise and counterclockwise rotor blades “successfully installed” in their corresponding shaft lock portions using the disclosed lock mechanisms. (See, *e.g.*, DJI-1001, 4:23-26, 4:38-40.)

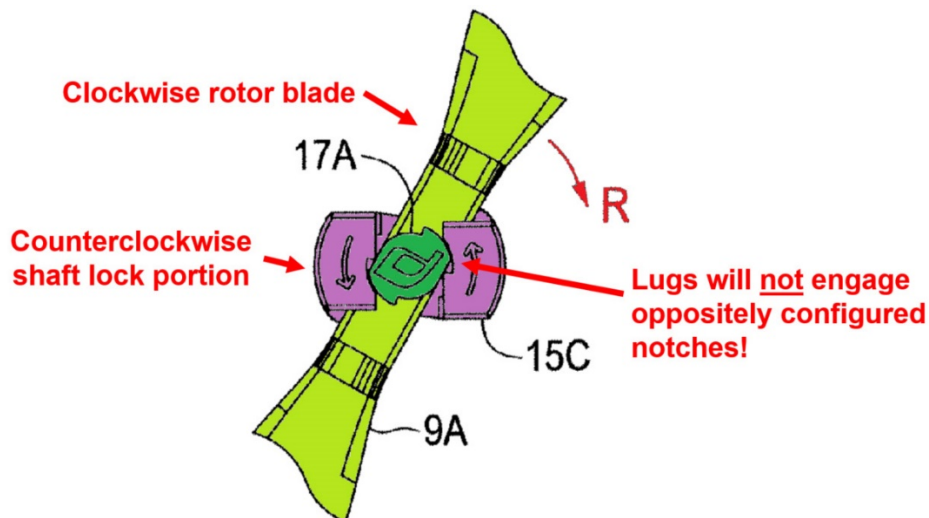


'184 Patent, Figure 7



'184 Patent, Figure 10

38. As shown below in annotated Figure 8 below, and explained by the '184 patent, it is my understanding that the disclosed lock mechanism prevents the clockwise rotor blade from being improperly attached to the counterclockwise driveshaft because the lugs on the blade lock portion of the clockwise rotor blade do not align with, and thus cannot engage, the oppositely configured notches of the shaft lock portion of the counterclockwise driveshaft. (See, e.g., 4:27-30, 2:2-7.)



'184 Patent, Figure 8 (annotated)

As the '184 patent states: “the clockwise rotor blades 9A, 9B cannot be installed on the shaft lock portion 15C of a counterclockwise lock mechanism, and similarly the counterclockwise rotor blades 9C, 9D cannot be installed on the shaft lock portion 15A of a clockwise lock mechanism.” (DJI-1001, 4:30-35.)

V. TECHNOLOGICAL BACKGROUND

39. As I discuss in detail in this section, the claims 1, 3 and 4 recite components that were independently well-known prior to the earliest possible priority date of the '184 patent. Below I describe how each of the components recited in claims 1, 3 and 4 were known, some for more than a century.

A. Basic Structure of a UAV

40. UAV's, also referred to as drones, were not only known, they were being sold commercially prior to the filing date of the '184 patent. I note that the paper “Design and Construction of a Quadrotor-type Unmanned Aerial Vehicle: Preliminary Results” by Sa (“Sa”) lists a number of commercially available UAVs including Draganflyer E4, the Parrot AR.Drone, and X-4 Flyer. Sa also mentions the Stanford Testbed of Autonomous Rotorcraft for Multi-Agent (STARMAC) device, Version II, and the OS4 Device which was developed by researchers in Switzerland. (DJI-1009, p. 2.)

41. Every multi-rotor UAV necessarily includes at least three core components: a body, two or more arms, and a rotor assembly attached to each arm.

As I noted above the '184 patent itself admits that this basic UAV structure was known:

Unmanned remote control rotary aircraft have recently become popular for recreation and also in larger and more sophisticated versions for surveillance by military and police personnel. One popular configuration includes a number of arms extending laterally from the aircraft body, with a rotor assembly on the end of each arm. The rotor assemblies sometimes have upper and lower rotors that rotate in opposite directions to avoid exerting torque on the body which would cause it to spin.

(DJI-1001, 1:15-23.) The figures in Table 1 of Sa also illustrate that available

UAVs had a main body from which two or more arms extend with a rotor assembly attached to each arm. (DJI-1009, p. 2.)

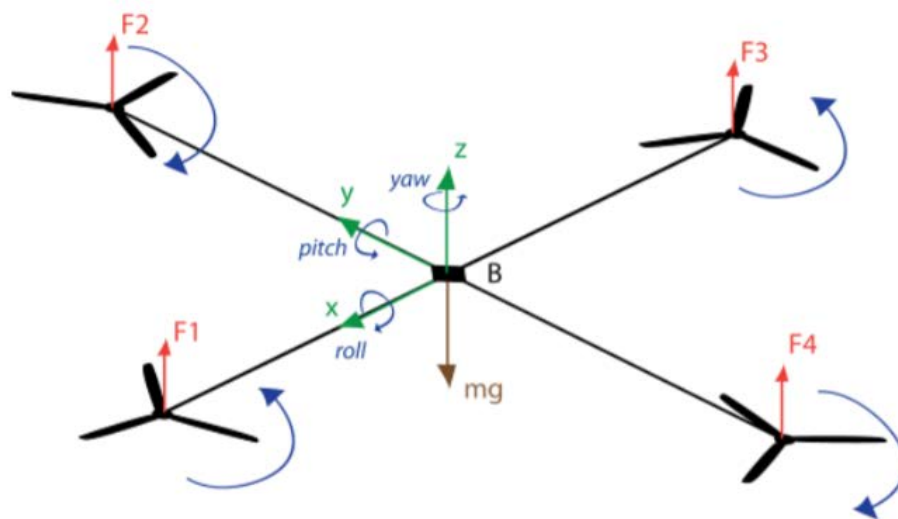
TABLE I. LIST OF QUADROTOR-LIKE AUV PROJECTS FOUND IN THE LITERATURE.

Projects	Structures
Draganflyer E4	
AR.Drone	
X-4 Flyer	
STARMAC II	
OS4	

42. The rotor assembly, which is also referred to as a propulsion assembly, is a critical component in a multi-rotor UAV which I describe in further detail in the following section. A rotor assembly includes a motor, a propeller, and a driveshaft

coupled to both the motor and the propeller. The driveshaft is a mechanical component for transmitting torque and rotation from the motor to the propeller.

43. An aircraft controls its flight by varying the torques (or moments) acting on the aircraft to cause rotations about the three principal aircraft axes that run through the center of gravity of the aircraft, known in the art as yaw, pitch, and roll. Yaw is rotation of the aircraft about its vertical axis, pitch is rotation about its transverse axis (*i.e.*, leaning forward or backward), and roll is rotation about its longitudinal axis (*i.e.*, leaning left or right). (DJI-1009, p. 4). Figure 5 of Sa, reproduced below, illustrates these concepts for a quadrotor UAV aircraft.



Sa, Figure 5

44. A multi-rotor rotary aircraft, such as claimed in the '184 patent, is controlled entirely by the application of torque on the three principal axes by the

propellers (also referred to as rotors, rotor blades or blades) themselves. (*see generally* DJI-1009, p. 4-5; DJI-1010, pp. 6-8.) The optimal design for a quadrotor aircraft, permitting the control of torque on all three principal axes, uses a pair of propellers that spin clockwise and an opposite pair of propellers that spin counterclockwise to cancel the propellers' torque effect. (*See* DJI-1011, p. 3; DJI-1010, pp. 2, 6.) This design has been known and fully conceptualized for decades. (DJI-1011, p. 3; DJI-1010, pp. 2, 6.) Indeed, the '184 patent indicates that this was a well-known concept explaining in the background section that "torque on the body from the rotational motion of the rotors is avoided by having the rotors rotate in opposite directions." (DJI-1001, 1:24-31.)

45. The movement of a quadrotor aircraft (UAV) is obtained by individually controlling the speed of the four propellers. (DJI-1011, p. 3; DJI-1010, pp. 6-8; DJI-1009, p. 2.) Two force components must be considered when controlling the UAV via propeller speed alone: torque and lift. The torque each propeller places on the UAV depends on the speed of rotation and the direction of rotation: higher rotation speed causes additional torque in the opposite direction of rotation. The lift provided depends entirely on rotation speed: higher rotation speed causes additional lift. Because two propellers rotate in the clockwise direction and two rotate in the counterclockwise direction, the clockwise propellers must have an opposite pitch (angle of attack) from the counterclockwise propellers in order to

generate lift. A propeller pitched to generate upward lift when spinning in the clockwise direction would generate downward lift when spinning in the counterclockwise direction. The quadrotor aircraft would not be controllable if a propeller designed for a clockwise rotor were to be inadvertently used in a counterclockwise rotor assembly. The well-understood concept drove manufacturers of commercial UAVs to “mistake proof” the coupling between the propeller assembly and the driveshaft to ensure users attached the propellers to the correct driveshafts.

46. The coupling between the propeller and the driveshaft is also subject to various forces during takeoff, flight, and landing which, if not accounted for, can result in separation of the propeller from the driveshaft. First, the design of the coupling between the driveshaft and the propeller must account for the torque generated during UAV operation. The primary torque acting on the coupling is the force generated by the rotation of the driveshaft itself. When the motor rotates the driveshaft in the clockwise direction, the clockwise rotation of the driveshaft imparts a corresponding clockwise torque (“drive torque”) on the propeller coupling which causes the propeller to also rotate in the clockwise direction.

47. The propeller does not rotate freely through the air: there is aerodynamic drag generated by the friction between the propeller and the air as the propeller is rotating, which imparts a torque (“drag torque”) on the propeller in a

direction opposite the rotation of the propeller. Drag torque in the counterclockwise direction is unavoidable while the UAV is in operation and the propeller is spinning and can loosen the coupling between the driveshaft and the propeller if unaccounted for. The greater the drag torque is relative to the drive torque, the greater the loosening effect will be due to the imbalanced torque forces on the coupling. Additionally, when the driveshaft accelerates or decelerates during takeoff, landing, or in-flight maneuvers, it imparts an additional torque on the coupling which changes the balance of the drive torque and drag torque. In threaded and twist-lock couplings, one of acceleration or deceleration of the driveshaft will tighten the coupling between the driveshaft and propeller.

48. The design of the coupling must also account for the opposing vertical forces generated during UAV operation. During UAV operation, the coupling is subject to the upward lift force generated by the rotation of the propeller. Additionally, when the UAV is in flight, the entire weight of the UAV is supported by the coupling so there is a corresponding downward force on the coupling equal to the weight of the UAV. The constant opposing upward and downward forces during flight would separate the coupling of the propeller and the driveshaft absent designing the coupling in such a way as to be able to support at least the weight of the UAV. When the driveshaft and propeller rotate faster the lift force is increased without a decrease in the weight of the UAV, which results in an increased

tendency of the coupling to separate during takeoff and in-flight maneuvers. Additionally, when a threaded coupling is used, the opposing vertical forces generate an additional clockwise or counterclockwise torque component depending on the direction of the threading (handedness) and thread angle used.

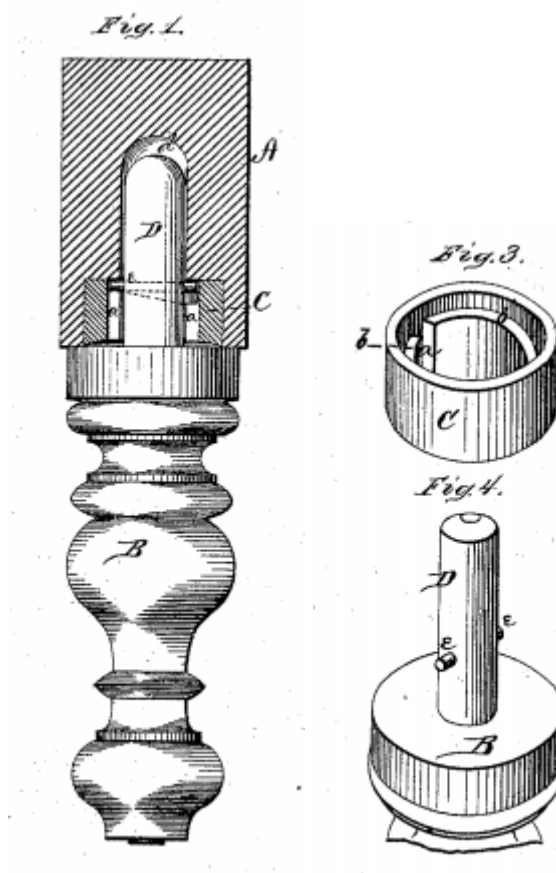
B. Coupling Mechanism

49. As I discussed above, the coupling mechanism limitations combine the concepts of a “keyed” connection, a lug-notch/twist-lock connection, and directional coupling. Each of these concepts were well-known known individually. The ’184 patent does nothing more than combine these well-known mechanical connection concepts together. Such a combination of features would have been well within the skills of a POSITA as of the earliest possible priority date of the ’184 patent. Indeed, many of the connections I describe below incorporate several of these concepts.

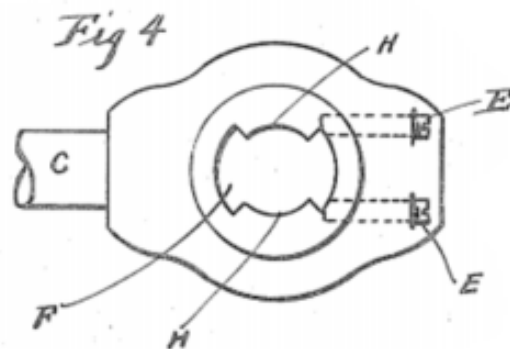
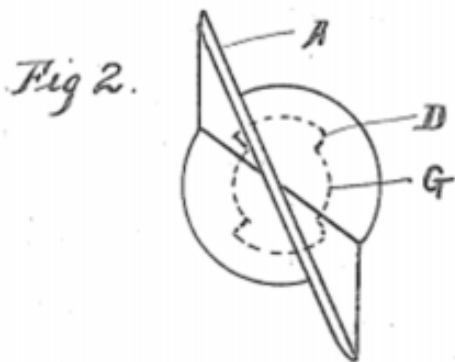
1. Twist-Lock and Lug/Notch connectors have been known for over a century.

50. The use of twist-lock connection mechanism is well-known and has been well-known for over a century. For example, U.S. Patent No. 135,655, issued in February 1873 (“the ’655 patent”), describes the use of a twist-lock mechanism to easily attach and detach legs to and from tables. As illustrated in Figures 1, 3 and 4 below, a casting C on the base of the table includes two vertical grooves, a a,

formed on its inner side and opposite each and two inclines, b b, each extending from one groove, a, to another. The leg includes a pin e. To attach the leg, the ends of the pin e on each side of the leg pass through groove a a. “The leg is then turned, when the ends of the pin e will move up on the inclines b b and secure the leg, the upper end of the leg and the lower end of the post forming a tight joint.” (DJI-1012.) I note that the ’655 patent acknowledged that the use of “incline b, with catches or lugs, has been before used in bedsteads.” (DJI-1012.) Thus, even in 1873, the use of lugs and notches in twist-lock configurations was not new.



51. The use of twist-lock couplings expanded beyond use in furniture. U.S. Patent No. 821,534 (“Perkins”), filed on June 2, 1905, describes the use of a twist-lock connector for coupling a propeller blade to a hub. Perkins recognized the need to provide a coupling mechanism that permitted a user to easily replace a propeller blade. Figure 2 of Perkins, reproduced below left, is an end view of a propeller and Figure 4, reproduced below right, is a top plan of the hub “showing the opening into which the shaft of the blade is inserted.” (DJI-1013, p. 2, lines: 21-28.) The propeller-blade, labeled A, includes a “short centrally-located portion” projecting from the end, labeled G. (DJI-1013, p. 2, lines: 58-63.) Perkins refers to this projection as a “shaft.” The end “carries a broken flange D,” two lugs extending from the circumference of the shaft.



52. The hub shown in Figure 4 includes an opening, labeled F, which receives the shaft of the propeller blade G. As shown in Figure 4, the hub opening is expanded at one or more places “so as to permit the flange D to pass therethrough.”

(DJI-1013, p. 2, lines: 67-73.) The hub further includes a pair of adjusting or locking screws or pins, labeled E, that “are adapted to bear against the corners of flanges D upon the blade-shafts when the blades are in position.” (DJI-1013, p. 2, lines: 81-87.) Thus, the blade portion has lugs and the hub of the driveshaft includes corresponding notches to receive the lugs.

53. To assemble, the blade is turned “so that the broken flange D will register with the opening in the broken flange H, and so will pass therethrough.” (DJI-1013, p. 2, lines: 90-94.) The blade is given “a quarter-turn or as much as may be necessary, and these two broken flanges D and H engage with each other, the flange D being under the flange H, so that withdrawal of the wheel is impossible.” (DJI-1013, p. 2, lines: 94-99.) That is, the blade is coupled to the hub via a twist-lock coupling.

2. **“Keyed” connection mechanisms were also well-known**

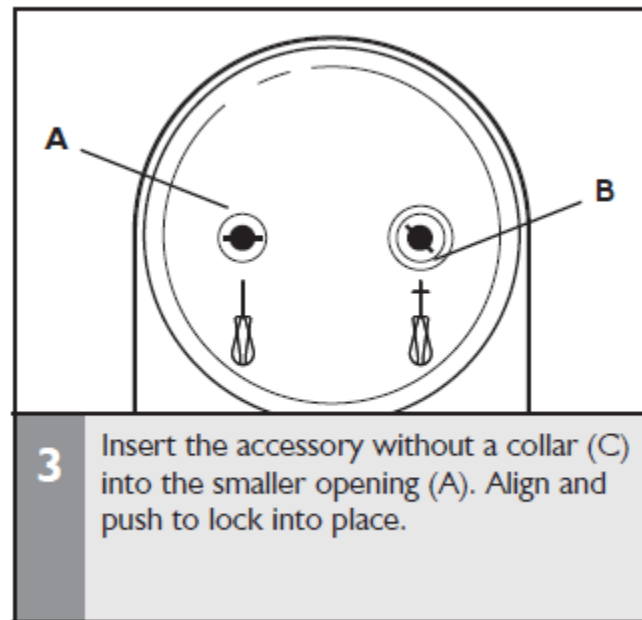
54. “Keyed” connection mechanisms have long been used in systems with multiple components with different shapes that require specific placement in a device or in systems with multiple rotating components in close proximity to avoid interference between the rotating components. Keyed connection mechanisms “mistake proof” the device, ensuring that a user couples the components in the correct manner. For example, keyed connections are commonly used in kitchen mixers. Kitchen mixers typically use two attachments simultaneously (*e.g.*, beaters,

dough hooks, etc.). It is critical that these attachments be positioned correctly to avoid interference during operation. Therefore, these appliances use a keyed connection to ensure that the attachments are positioned properly.

55. Keyed connections are also commonly used to couple UAV propellers to their associated driveshafts as discussed in the previous section. UAVs have propellers that rotate in a clockwise direction and propellers that rotate in a counterclockwise direction as I discussed in detail above. The clockwise propellers have a specific pitch - counterclockwise have a different pitch. Therefore, it is important that clockwise propellers are only used on clockwise driveshafts and counterclockwise propellers are only used on the counterclockwise driveshafts. For example, Contra Rotating Propeller Drive System User Guide, dates prior to the filing date of the '184 patent uses a mistake-proofing technique for its propellers: “[E]ach propeller is designed so that it can only fit on the front or the rear, whichever is appropriate for each propeller. This means that it is not possible to incorrectly assemble either prop.” (DJI-1014, p. 3.)

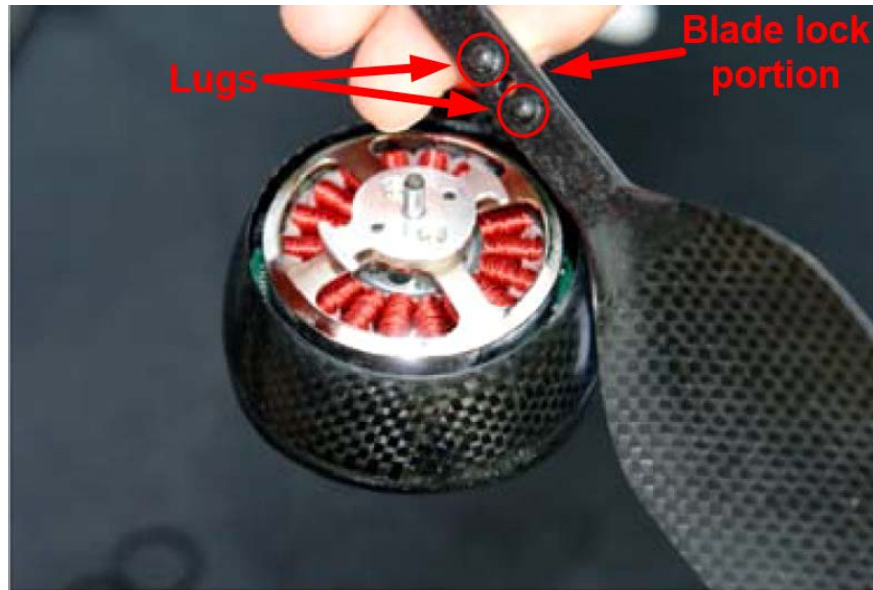
56. A wide variety of keyed connections are possible including connections keyed based on size of the connecting parts, based on shape of the connecting parts, and based on positioning of the connecting parts. The following figure illustrates the “keyed” connection based on size of the connecting parts for a KitchenAid Mixer. In this connection, one beater includes a collar increasing the

size of the connection and another beater does not include the collar. The body of the mixer therefore prevents a user from coupling the collar beater to the incorrect opening. (KitchenAid, p. 10.) That is, the beater with the larger collar cannot be used in the connection with the smaller opening.



57. Version 2.2 of the User Manual for the Microdrones md4-200 (“Microdrones”) teaches a “keyed” connection based on positioning of the connecting parts. Microdrones discloses a rotary wing aircraft (quadcopter, UAV). As shown in Figure 25 below, Microdrones rotor blade has two lugs that are inserted into corresponding notches on the driveshaft. Microdrones “keys” its connection mechanism by altering the positioning of the lugs on the clockwise and counterclockwise propellers. Specifically, Microdrones’ clockwise lock mechanism differs from its counterclockwise lock mechanism in that the distance between the

lugs on the center bar of the rotor blade and the matching notches on the rotor mounting plate is “individual” (*i.e.*, unique) and thus different. (DJI-1016, p. 27 (“To avoid accidental misplacement, both directions of turning use individual distances between these knobs.”).)



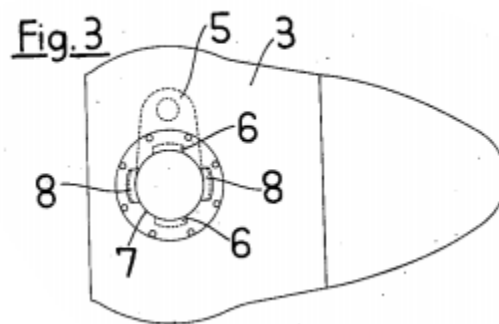
Microdrones, Figure 25

3. Directionality of Coupling

58. As I discussed above, it was well-known, long before the '184 patent, that rotational forces impact the connection between a rotating component (*e.g.*, a driveshaft) and another component (*e.g.*, propeller or blade). Connection mechanisms which are twisted or turned to a position such that the connection resists the rotational forces (referred to herein as directional connection

mechanisms) are commonly used in devices requiring connection with a rotating component such as marine propellers, fans, and UAVs.

59. U.S. Patent 2,470,517 to Obrist (“Obrist”), filed in 1945, describes a directional twist-lock coupling mechanism for a variable-pitch marine propeller. In Obrist, the root of the blade includes two projections 6 arranged opposite to one another. (DJI-1017, 2:28-32.) The propeller hub includes two recesses 8 that are slightly larger than the projections 6. (DJI-1017, 2:38-42.) The lugs are introduced through recesses 8, the blade root is turned about 90° so that “the lugs 6 are displaced from the recesses 8 through which they entered, and engage an arcuate seat formed therefore on the internal face of the hub” as shown in Figure 3 of Obrist below. (DJI-1017, 2:44-54.)

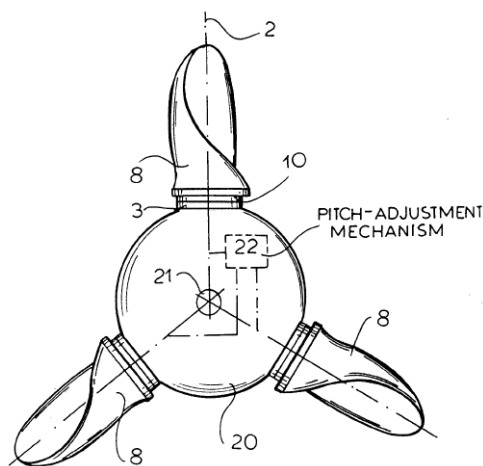


Obrist, Figure 3

60. Obrist notes that “[i]n this position the projections 6 act as a lock with regard to the centrifugal forces exerted on the correlated blade 1 in that they rest

directly against the inner surface of the hub 3.” (DJI-1017, 2:55-3:4.) Thus, in
Obrist the lug/notch connection is configured to twist so that the connection
remains locked when system is exposed to centrifugal forces.

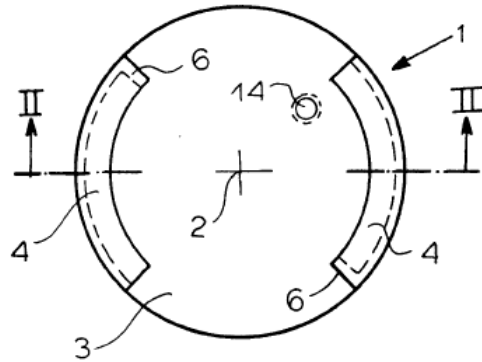
61. European Patent Application EP 0921067 to Muller (“EP067”) describes a directional coupling mechanism for use with propeller assemblies. EP067 is directed to a mechanism “to simplify the mounting and dismounting of the blades of a propeller.” (DJI-1018, ¶[0004].) Figure 5 of EP067 (reproduced below) illustrates “the hub of the variable-pitch propeller.” (DJI-1018, ¶[0007].) A plurality of blade support plates 10 are spaced apart on the hub and are rotatable about their respective radial axes. (DJI-1018, ¶[0012].) A plurality of blade members 2 are affixed to the blade support plates 10. (DJI-1018, ¶[0012].)



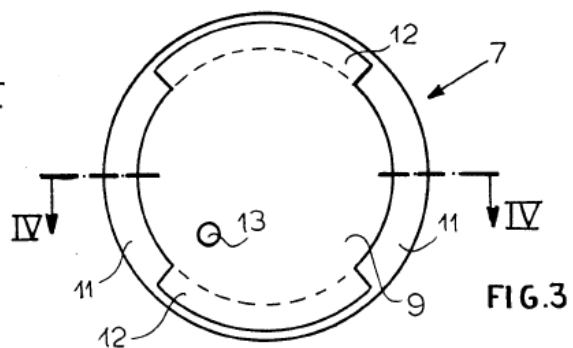
EP067, Figure 5

62. Figure 1 (reproduced below left) illustrates the blade support plate 1. The upper side of the blade support plate 1 includes “two diametrically-opposite

claws 4 projecting radially inwardly and extending along the circumference of the respective plate.” (DJI-1018, ¶[0018].) “Between the claws 4 there remain gaps in the circumferential direction and between each claw 4 and the planar upper side of the plate, there is left a gap 5.” (DJI-1018, ¶[0018].) Each of the claws 4 is provided at one end with an abutment or stop 6. (DJI-1018, ¶[0018].) Figure 3 is a plan view of the underside of the base of a blade. (DJI-1018, ¶[0015].) As seen in Figure 3 (below), “each of the blades 8 has a blade foot or base 7 having a planar underside 9 and a circumferential groove extending over the entire periphery.” (DJI-1018, ¶[0019].) The circumferential groove has two radially-opposite cutouts 11 between which the radial projections 12 are disposed. (DJI-1018, ¶[0019].)



EP067, Figure 1



EP067, Figure 3

63. For mounting of a blade, “the base of the new blade is fitted onto the plate so that the claws engage in the cutouts and the blade is then rotated through a fraction of a full revolution about its radial axis until the claws engage in the groove and the projections engaged beneath the claws.” (DJI-1018, ¶[0008].) The “base 7

thereof is juxtaposed with its underside 9 with the upper side 3 of a respective plate that the claws 4 engaged in the cutouts 11 of the base and thus so that the claws are circumferentially aligned with and are in the plane of the circumferential groove.” (DJI-1018, ¶[0021].) The propeller blade 8 and 6 “is rotated about its radial axis 2 so that the claws 4 are engaged in the groove 10 and the projections 12 underlie the claws.” (DJI-1018, ¶[0021].) The blade is rotated until one or both of its projections 12 come to abut a stop 6. (DJI-1018, ¶[0021].) Dismounting of the blade can be effected by an angular displacement of the blade relative to the plate in the opposite sense so that the claws and the projections are angularly offset from one another. (DJI-1018, ¶[0008].) EP067 explains that “the reaction force in rotation of the propeller, maintains the respective projection against the stop.” (DJI-1018, ¶[0011].)

64. Threaded screws are also an extremely common and well-known type of directional coupling (fastening) mechanism. A screw has a thread which is a helical structure (protrusion wrapped around a cylinder in the form of helix). The helix of a thread can twist in two possible directions – right (or right-handed) and left (or left-handed). With a right-hand thread, turning the screw clockwise inserts or tightens the screw; turning the screw counterclockwise loosens or removes the screw. With a left-hand thread, turning the screw clockwise loosens or removes the screw; turning the screw counterclockwise inserts or tightens the screw. A screw

has a corresponding hole or socket (*e.g.*, nut) with corresponding threads. For example, a screw with right-handed male threads has a hole or socket (*e.g.*, nut) with right-handed female threads and a screw with left-handed male threads has a hole or socket (*e.g.*, nut) with left-handed female threads. Therefore, threaded connections are also “keyed”—a right-handed screw cannot be used with a left-handed hole, and vice versa.

65. It was known that when a directionally threaded screw is used with to fasten a component to a rotating shaft, the direction of rotation of the shaft may cause the thread to loosen instead of tighten. A right-handed thread tightens with clockwise rotation and a left-handed thread tightens with counterclockwise rotation. For example, in a bicycle, the left pedal turns around the crank in a counterclockwise direction. If the pedal used a right-hand screw, the pedal could loosen or fall off during operation of the bicycle.

66. Sasaki, discussed in detail below, describes the use of directionally threaded screws in a quadcopter. When used to fasten (couple) a propeller to a driveshaft, a nut is buried in the central portion of the propeller. (DJI-1006, 1:50-2:1.) The nut is attached to a screw shaft formed at the top end of the rotating driveshaft. (DJI-1006, 2:1-4.) Sasaki explains that “it is necessary to manufacture a propeller which rotates right with a left screw, and a propeller which rotates left with a right nut (8) and a rotating shaft (73).” (DJI-1006, 2:5-9.) The nut and shaft

therefore receive a force in the tightening direction due to the rotation of the propeller.

VI. LEVEL OF ORDINARY SKILL IN THE ART

67. I understand that the level of ordinary skill may be reflected by the prior art of record, and that a POSITA to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art.

68. I understand that the level of ordinary skill may be reflected by the prior art of record, and that a POSITA to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art.

69. I understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including: (a) the levels of education and experience of persons working in the field at the time of the invention; (b) the sophistication of the technology; (c) the types of problems encountered in the field; and (d) the prior art solutions to those problems.

70. I have been informed that the earliest possible priority date of the '184 is May 15, 2013 and that is relevant to the analysis in my declaration. For the purposes of my analysis, I have used the May 15, 2013 date as the relevant date.

71. I considered several factors to determine the skill level of a person of ordinary skill in the art of the '184 patent in May 2013, including the types of problems encountered in the art, the solutions to those problems, the pace of innovation in the field, the sophistication of the technology, and the education level of active workers in the field.

72. Based on my knowledge, expertise, and the prior art cited in the '184 patent, it is my opinion that a person of ordinary skill in the field of the '184 patent would have had at least an undergraduate degree in mechanical engineering, or equivalent education, training, or experience, with at least two years of experience with UAVs.

73. Unless noted otherwise, when I state that something would be known or understood by one skilled in the art, or a skilled artisan, or a POSITA, I am referring to a person with this level of education and experience in or around May 2013.

VII. CLAIM CONSTRUCTION

74. I understand that the Patent Office applies the claim construction standard used in district courts which seeks to give claim terms their plain and ordinary meaning to a POSITA at the time of the claimed invention. I also understand that if the patent applicant gave a term a special meaning in the specification or during prosecution, then that special meaning should be used. My

analysis uses the plain and ordinary meaning of the claim terms. The plain and ordinary meaning is consistent with the specification of the '184 patent. I further understand that intrinsic evidence includes the prosecution history of a patent, prior art cited patents, and related patents for guidance in claim construction.

75. It is also my understanding that the Board may also look to extrinsic evidence for a variety of purposes, including for providing background on the technology at issue, explaining how an invention works, ensuring that the court's understanding of the technical aspects of the patent is consistent with that of a person of skill in the art, or establishing that a particular term in the patent or the prior art has a particular meaning in the pertinent/technical field. I understand that some examples of extrinsic evidence are things such as inventor testimony, dictionaries, treatises, and expert testimony.

76. I have followed these principles in my analysis throughout this declaration. I discuss below the meaning of certain claim terms that I have applied in forming my opinions. I also have been informed that the Patent Owner filed a preliminary response in IPR2019-00343 setting forth proposed constructions of certain terms. (*See* DJI-1019, pp. 13-20.)

A. “lock mechanism,” “clockwise lock mechanism,” counterclockwise lock mechanism” (Claims 3-4)

77. Independent claim 1 recites that “*each rotor assembly compris[es] a rotor blade releasably attached to a driveshaft by a lock mechanism,*” that “*a clockwise rotor blade is releasably attached to the first driveshaft by engagement in a clockwise lock mechanism,*” and that a “*counterclockwise rotor blade is releasably attached to the second driveshaft by engagement in a counterclockwise lock mechanism.*” Claim 1 also recites that “*the clockwise lock mechanism comprises a shaft lock portion...and a blade lock portion,*” and claim 2 recites that “the clockwise lock mechanism comprises a shaft lock portion...and a blade lock portion.”

78. As I briefly discussed above, I believe that construing these terms helps clarify that the recited “lock mechanisms” may include more than one component (and components other than those specifically recited in the claims) to releasably attach the rotor blades. In my opinion nothing in the claims or specification restricts the recited lock mechanisms to consist of only the recited “shaft lock portion” and “blade lock portion.” Rather, the claims recite that the “[clockwise / counterclockwise] lock mechanism comprises a shaft lock portion...and a blade lock portion,” leaving open the possibility that the lock mechanism may include other components that enable releasable attachment of the

rotor blades. This belief would be further confirmed by the '184 patent's own lock mechanism that also includes at least slot 23 on the shaft lock portion, which help to releasably attach the rotor blades. (See DJI-1001, Figure 9, 4:1-8.)

79. I have been informed that “comprises” is synonymous with includes, contains, or characterized by and is inclusive or open-ended and **does not exclude additional, unrecited elements** or method steps. This information aligns with my opinion that the specification also uses the open-ended term “comprises” when describing components that make-up the clockwise and counterclockwise lock mechanisms. (See DJI-1001, 3:55-62 (emphasis added).) Thus, a POSITA would have understood that the recited “lock mechanism” could potentially include additional components used to releasably attach the blade.

80. This understanding would have been confirmed by the various dictionary definitions of a “mechanism.” (See DJI-1020, p. 843 (defining “mechanism” as “[t]he arrangement of connected parts in a machine” and a “system of parts that operate or interact like those of a machine”).)

81. Therefore, my opinion is that the meaning of “lock mechanism,” “clockwise lock mechanism,” and “counterclockwise lock mechanism” is “one or more components that enable a [rotor blade / clockwise rotor blade / counterclockwise rotor blade] to be releasably attached.”

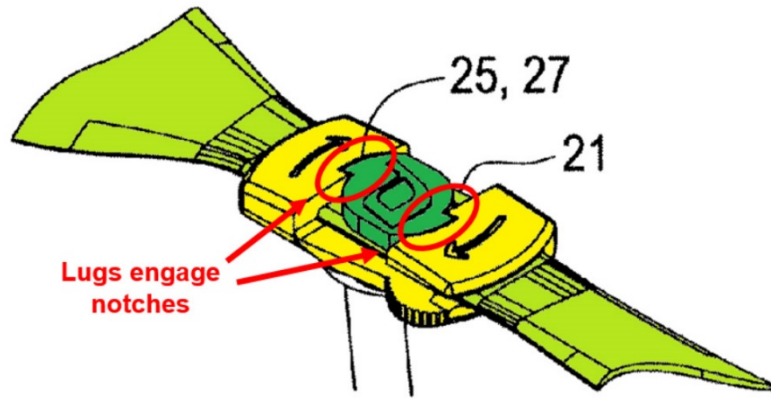
82. I note that Patent Owner contends that the terms “lock mechanism,” “shaft lock portion,” and “blade lock portion” should be given their “plain and ordinary meaning.” (DJI-1019, p. 15.) Specifically, Patent Owner does not offer an express construction; instead arguing that “[b]ecause the ’184 patent claims and specification make clear that the shaft lock portion and blade lock portion must form a lock mechanism, the claims do not cover devices where these claim requirements are evaded or where additional components – other than the shaft lock portion and blade lock portion – serve the function of attaching the rotor blade to the driveshaft.” (DJI-1019, pp. 19-20.) I disagree with the Patent Owner’s statements for the reasons I discussed above. However, as I discuss below, the prior art applied in this proceeding discloses the claims regardless of the interpretation applied.

B. “lugs” and “notches” (Claim 1)

83. Claim 1 recites “*the shaft lock portion defining notches configured to engage corresponding lugs on the blade lock portion.*”

84. I believe that the construction of these terms is again necessary to clarify their meanings in the mechanical context. The ’184 patent teaches that the blade lock portion (dark green) has “lugs” (25), which are simply projections that engage “notches” (27) on the shaft lock portion (yellow), as shown in annotated

Figure 5 below. (See DJI-1001, 4:3-6 (“[L]ugs 25A on the blade lock portion 17A engage notches 27A defined by the shaft lock portion as seen in FIG. 5.”).)



'184 Patent, Figure 5

85. A POSITA would have understood that “lugs” are projections and that these projections could, together with the notches, provide support or a fitting connection. This understanding would be confirmed by the contemporaneous dictionary definitions of the noun “lug.” (See DJI-1021, p. 1177 (defining “lug” as a “projection or head on a metal part to serve as a cap, handle, support, or fitting connection”); DJI-1020, p. 806 (defining “lug” as “a handle or projection used as a hold or support” and a “projection that helps provide traction”).)

86. A POSITA would further have understood that “notches” are simply indentations, which, in view of claim 1, would be designed to “engage” the “lugs.” This understanding would also be confirmed by the contemporaneous dictionary

definitions of “notch.” (*See, e.g.*, DJI-1022, p. 1163 (defining “notch” as “an indentation or incision on an edge or surface”).)

87. Therefore, in my opinion, “lugs” are “projections” and “notches” are “indentations.” These constructions comport with the usage of these terms in the ’184 patent, where the “the shaft lock portion defin[es] **notches** [(i.e., **indentations**)] to engage corresponding lugs [(i.e., **projections**)] on the blade lock portion.”

88. I note that Patent Owner did not provide an express construction for these terms in its preliminary response. (*See* DJI-1019, pp. 13-20.)

C. “drive” (Claim 1)

89. Claim 1 recites “a drive rotating the driveshaft.” A construction to clarify the meaning of “drive” is advantageous here. Upon my review as to what a “drive” may be in the ’184 patent, I found that it is “typically an electric motor, rotating the driveshaft.” (DJI-1001, 3:20-21.) As claim 1 recites “a drive,” not just “an electric motor,” a POSITA would have understood the term “drive” to include, but not be limited to, an electric motor. Instead, a POSITA would have understood “a drive” to be any component that can impart a force to cause motion.

90. This understanding would be confirmed by the contemporaneous dictionary definitions of the term “drive.” (*See* DJI-1023, p. 384 (defining “drive” as “to impart a forward motion to by physical force”); DJI-1021, p. 616 (defining

“drive” as “[t]he means by which a machine is given motion or power..., or by which power is transferred from one part of a machine to another (as in gear drive, belt drive”).)

91. Therefore, in my opinion, a “drive” is a “component that imparts motion.”

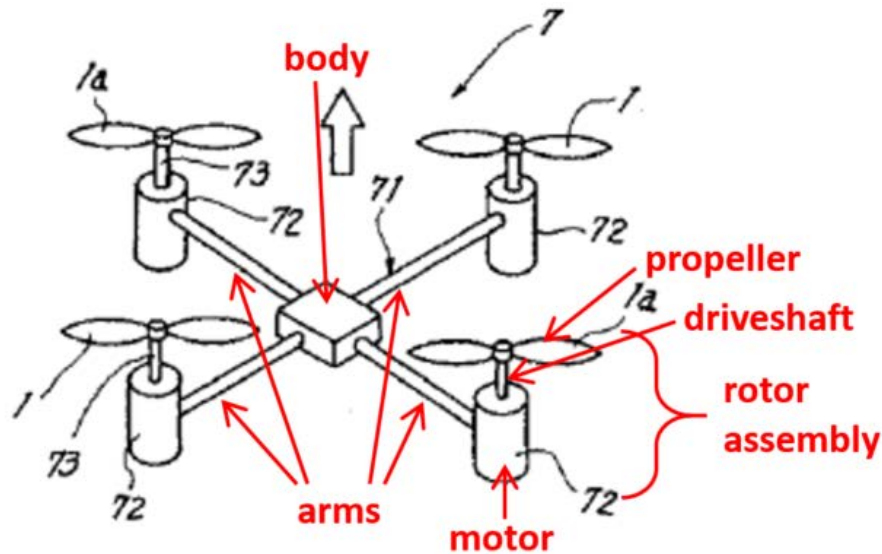
VIII. GROUND 1: COMBINATION OF SASAKI AND SOKN

92. In this section, I discuss the application of Sasaki in combination with Sokn against the challenged claims. As detailed below, this combination discloses each of the limitations of claims 1, 3 and 4 arranged as claimed. Although the petition only challenges dependent claims 3 and 4, because these claims dependent from independent claim 1, I also address the applicability of the combination against independent claim 1.

A. Overview of Sasaki

93. Sasaki is directed to “a propeller for a flying toy and a fixture thereof that are used in a flying toy.” (DJI-1006, 1:32-34.) Figure 7 (reproduced below with annotations) illustrates Sasaki’s flying toy. As shown in Figure 7, Sasaki’s UAV includes a body with four arms extending therefrom. Each arm includes a rotor assembly comprising a propeller, a motor, and a driveshaft coupled to both the propeller and motor. Thus, although Sasaki describes its apparatus as a “flying toy,”

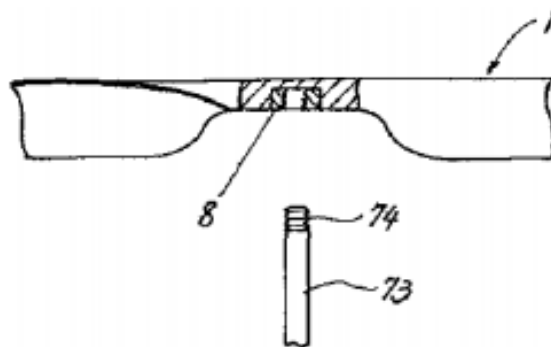
a POSITA would have recognized that Sasaki's apparatus is a UAV, specifically a quadcopter. Sasaki's UAV includes each of the claimed UAV structural limitations, limitations that the '184 patent itself admits were known in the prior art.



Sasaki, Figure 7 (annotated)

94. Sasaki teaches that “[o]ne group of propellers (1) facing diagonally rotates in the direction opposite to the direction of rotation of the other group of propellers (1a), and the reaction force occurring due to the rotation of each set of propellers (1) (1a) is canceled by one another so that the flying toy can fly.” (DJI-1006, 4:8-14.) As I discussed above, quadcopter design having two propellers that rotate in the clockwise direction and two that rotate in the counterclockwise direction were well known and in fact in use prior to the earliest possible priority date of the '184 patent.

95. Sasaki explains that “[t]he propellers (1) (1a) are each detachably attached to a top end of the upward rotating shaft (73) of the motor (72).” (DJI-1006, 4:27-29.) Sasaki describes a technique used in the prior art to “detachably attach” a propeller. Specifically, Sasaki describes that the propeller is fastened to the rotating shaft through a threaded nut and screw coupling. I described the threaded screw fastening mechanism above in the technological background section. Figure 8 (reproduced below) depicts the threaded screw coupling mechanism. Specifically, a nut is buried “in the central portion of the propeller (1)” (a socket) and a screw shaft (74) is “formed at a top end of a rotating shaft (73).” (DJI-1006, 1:49-2:4.) To couple the propeller to the shaft, the propeller/nut is rotated to screw the propeller to the shaft portion (74) of the shaft (73).



Sasaki, Figure 8

96. Sasaki teaches that in this threaded screw embodiment, the clockwise propellers use a clockwise lock mechanism—a left screw and associated nut. (DJI-1006, 2:5-7 (“For this reason, it is necessary to manufacture a propeller which

rotates right with a left screw.”).) To couple the clockwise propeller to the base, the propeller is twisted (screwed) in a counterclockwise direction. Sasaki also teaches that its counterclockwise propellers use a counterclockwise lock mechanism—a right screw and associated nut. (DJI-1006, 2:7-8 (“it is necessary to manufacture ... a propeller which rotates left with a right nut (8) and a rotating shaft (73)”)).) To couple the counterclockwise propeller to the base, the propeller is twisted (screwed) in a clockwise direction. Because of this directional threading, the clockwise propeller cannot be used on the counterclockwise driveshaft and vice versa. That is, with this coupling mechanism, the user cannot place a propeller on the wrong driveshaft—that is, the coupling mechanism is “mistake-proof.”

97. In the directionally threaded screw mechanism, “the nut (8) and the rotating shaft (73) receive a force in the tightening 10 direction due to the rotation of the propeller.” (DJI-1006, 2:9-11.) However, these same forces can cause the nut and rotating shaft of the propeller to be “tightened more than necessary” making the propeller more difficult to remove. Thus, a POSITA would be motivated based on this disclosure to replace the nut/screw locking mechanism with a mechanism that does not suffer from the overtightening problem. I note that Sasaki proposes a fixture to address the overtightening problem in the prior art UAV. (See DJI-1006, 2:30-9:12.)

98. Figure 2 of Sasaki illustrates Sasaki's "fixture (4) for attaching the propeller (1) to the rotating shaft (73)." (DJI-1006, 5:31-32.) Figure 1 illustrates Sasaki's propellers. As shown in Figure 1, "the propeller (1) is configured by a propeller main body (2) ... a reinforcement member (3) mounted on the center of an upper surface of the main body." (DJI-1006, 4:30-35.) The propeller main body (2) "has a plurality of wing pieces (23) integrally formed from a narrow mounting portion (21) of the central portion." (DJI-1006, 4:36-39.)

99. Sasaki's fixture includes a first locking member (5) "with a cylindrical shaft (52) at a central portion of a base plate (51) formed in a substantially cross shape and a through hole (53) [] set in the cylindrical shaft (52) so that the rotating shaft (73) is tightly fitted thereto." (DJI-1006, 5:38-44.) Claw pieces (54) protrude downward "at both ends of the base plate (51) in a transverse direction, and the top end of the claw piece (54) is bent inwardly to form a retaining piece (55)." (DJI-1006, 5:45-48.) A "second locking member (6) is downwardly provided with a cylindrical shaft (62) at the center of a substantially rectangular base plate (61), and a through hole (63) is set in the cylindrical shaft (62) so that the rotating shaft (73) is tightly fitted thereon." (DJI-1006, 6:2-7.) Figures 1 and 2 "show a propeller for rotating left, but in the propeller for rotating right, the twisting direction of the wing pieces (23) is opposite to that of the propellers of" Figures 1 and 2. (DJI-1006, 4:48-5:3.)

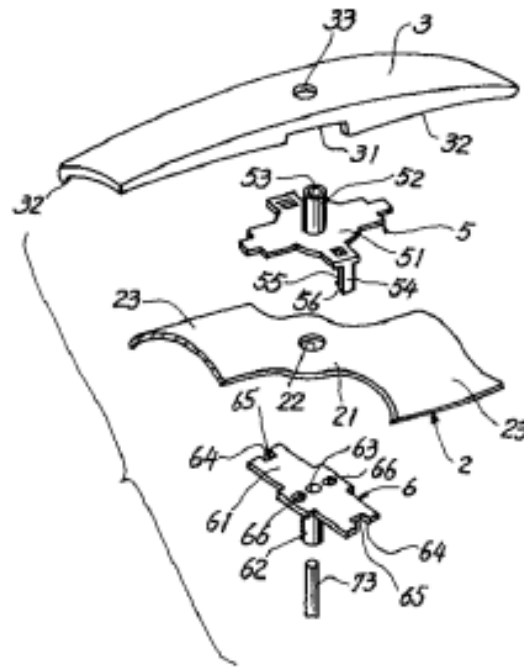


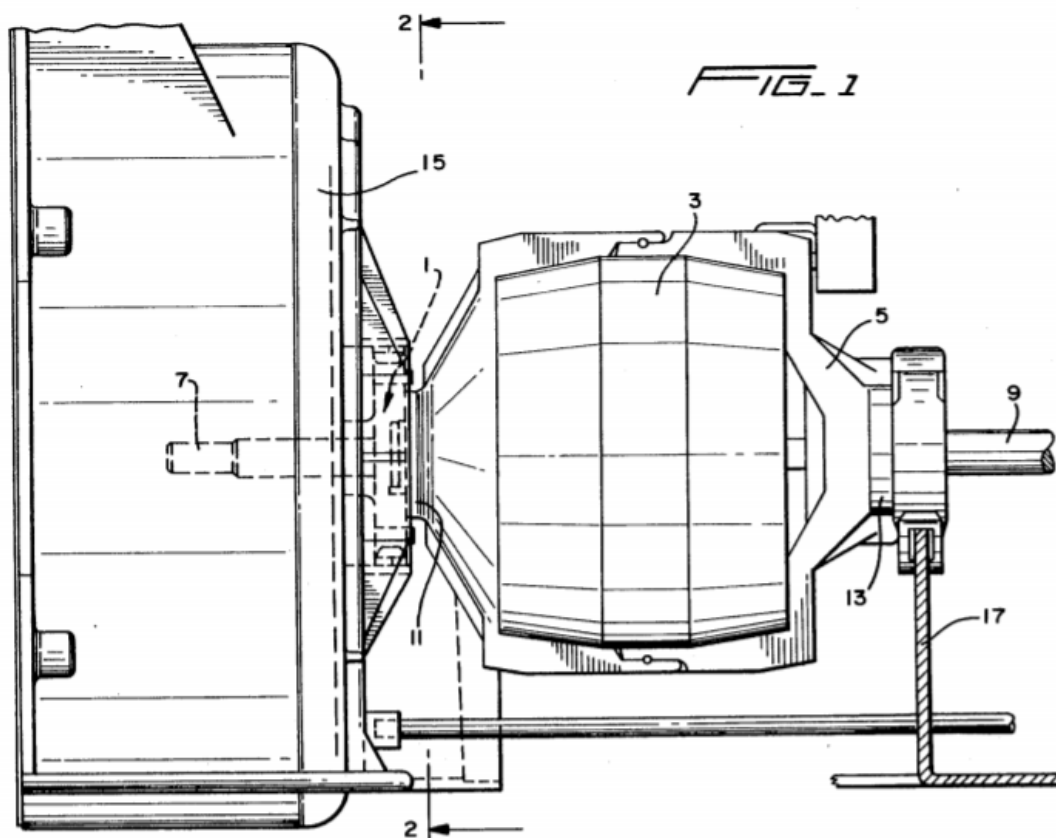
Fig. 2

100. A POSITA would recognize that although Sasaki's proposed fixture addresses the overtightening problem, the fixture has limitations, particularly for commercial applications of UAV. Sasaki's fixture is non-directional. The same coupling mechanism can be used with both clockwise and counterclockwise propellers. By replacing the directionally threaded screw coupling mechanism with a non-directional coupling mechanism, Sasaki's solution is no longer "mistake-proof" from an end-user's perspective. It is therefore possible for a user to place a propeller on the wrong driveshaft (*e.g.*, place a clockwise propeller on a counterclockwise driveshaft). Additionally, Sasaki's solution is more complicated

to manufacture because of the number of components and more difficult for a user to manipulate in the field than a simple screw/nut fastener. Therefore, a POSITA would have been motivated to address the overtightening problem in Sasaki's prior art UAV with a simple, easy to use coupling mechanism that maintains the "mistake-proofing" of the prior art. Sokn discloses such a coupling mechanism.

B. Overview of Sokn

101. Sokn describes a mechanism for mounting a fan motor to a fan housing using a segmented threaded coupling "to provide precise alignment" between the components. (DJI-1007, 1:9-11.) Sokn's locking mechanism is therefore a modification of the threaded locking mechanism of Sasaki. Figure 1 of Sokn (reproduced below) illustrates a front elevational view of a fan motor mounted to an associated fan housing by a motor mount assembly. (DJI-1007, 2:21-24.) As shown in Figure 1, the electric motor 3 includes "a pair of oppositely directed power output shafts 7 and 9." (DJI-1007, 2:47-49.) Shaft 7 extends coaxially and outwardly from a first hub 11. (DJI-1007, 2:49-50.) Sokn's motor mount assembly 1 "is mounted onto hub 11 and serves to directly mount the corresponding end of motor 3 to an associated fan housing 15." (DJI-1007, 2:51-54.) The "end of the shaft 7 is disposed within housing 15 for mounting an appropriate fan blade thereon." (DJI-1007, 2:54-56.)

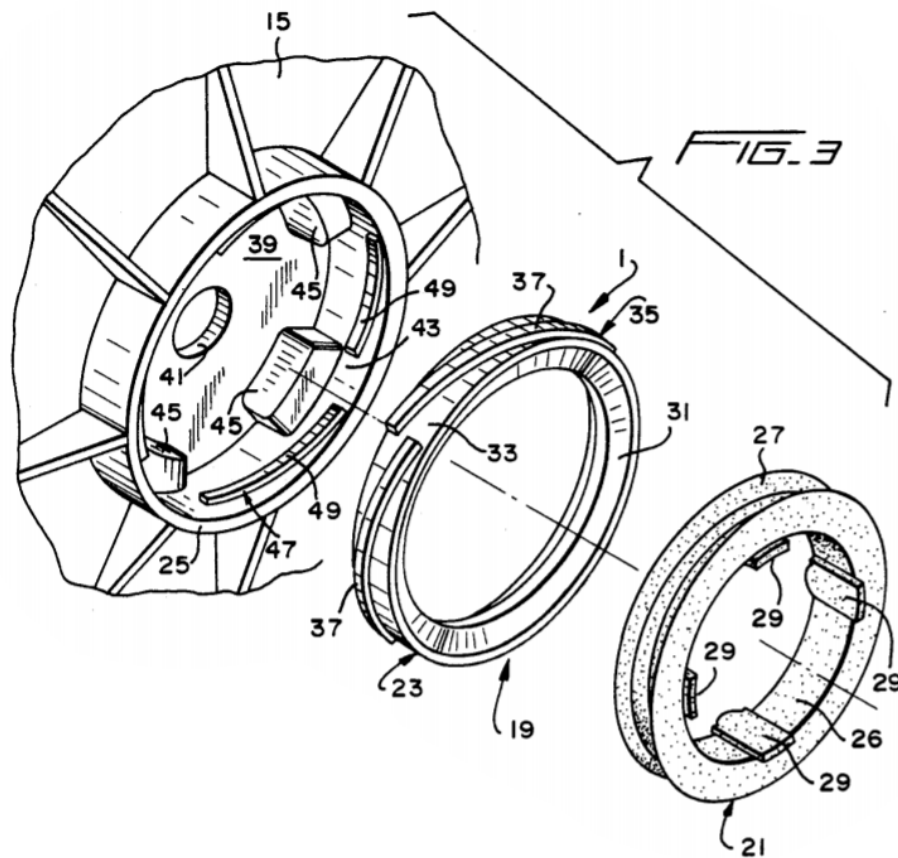


Sokn, Figure 1

102. Figure 3 “is a partial exploded perspective view showing the details of the mounting ring assembly and the cylindrical socket carried by the fan housing.” (DJI-1007, 2:28-31.) As illustrated in Figure 3 reproduced below, Sokn’s coupling mechanism includes a mounting ring assembly 19 comprised of an internal ring 21 supported within an external ring 23 and a cylindrical socket 25. (DJI-1007, 2:59-64.) Internal ring 21 includes an inner peripheral surface 26 and an outer peripheral surface 27. (DJI-1007, 3:10-11.) “A plurality of axially extending tabs 29 are circumferentially spaced around inner peripheral surface 29 to permit ring 21 to be

mounted directly onto hub 11 of motor 3 in a conventional manner.” (DJI-1007, 3:11-15.)

103. Like internal ring 21, external ring 23 also includes an inner peripheral surface 31 and an outer peripheral surface 33. (DJI-1007, 3:16-19.) The outer peripheral surface 27 of the inner ring 21 is of opposite configuration to the inner peripheral surface 31 of ring 23, permitting the inner ring 21 to be coaxially positioned within ring 19. (DJI-1007, 3:19-24.) The outer surface 33 of external ring 23 is provided with a first engagement portion a raised helical thread defined by a plurality of circumferentially spaced thread segments 37 and notches therebetween as shown in Figure 3 below. (DJI-1007, 3:28-34.) In Sokn, “[i]t is preferred that four segments 37 be provided and equally spaced 90° from each other around surface 33.” (DJI-1007, 3:32-34.)



104. Socket 25 includes a second engagement portion 47 on inner cylindrical surface 43 having a thread configuration corresponding to that of the first engagement portion 35. Second engagement portion 47 is defined by a plurality of protruding thread segments 49 which extend inwardly from the inner cylindrical surface 43. (DJI-1007, 3:49-52.) Socket 25 further includes a plurality of stop members 45 equally and circumferentially spaced around surface 43. (DJI-1007, 3:40-42.) For example, [p]ortion 47 is defined by four corresponding thread segments 49 which extend inwardly from surface 43 and are equally and

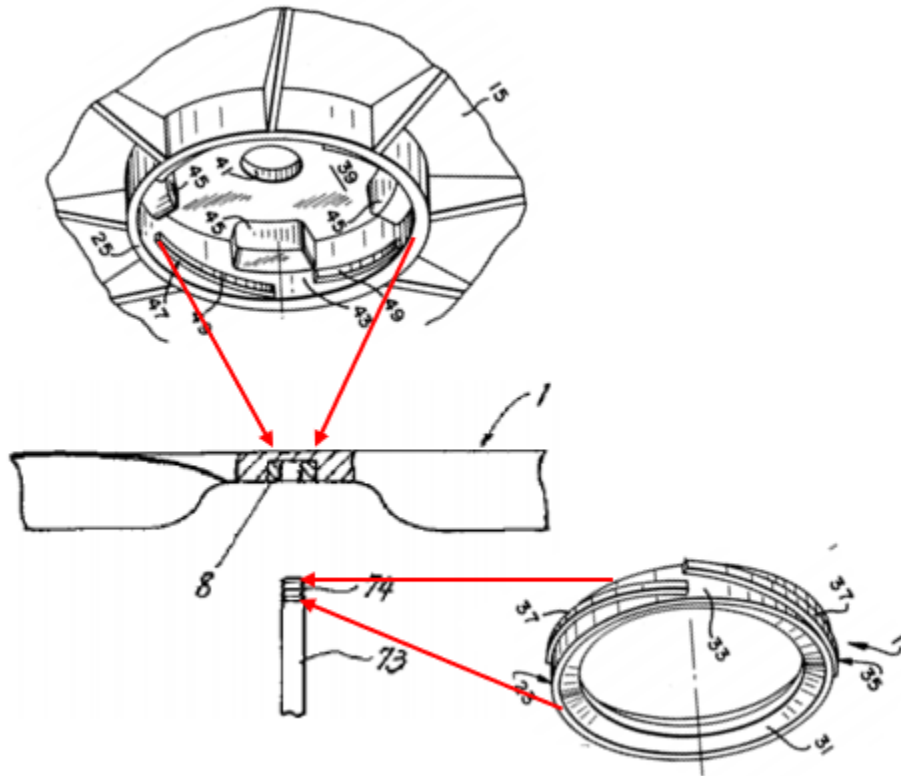
circumferentially spaced 90° around surface 43. (DJI-1007, 3:49-52.) The protruding thread segments 49 are spaced forwardly of stop members 45. (DJI-1007, 3:52-53.)

105. Sokn explains that “[t]hrough this arrangement, a large and easily alignable target area is established between the mounting ring assembly 19 and socket 25 so that ring assembly 19 may be easily aligned and inserted within socket 25.” (DJI-1007, 3:53-57.) During the mounting process, ring assembly 19 is rotated 90° with respect to socket 25, resulting “in a secure and aligned interlock connection.” (DJI-1007, 3:57-59.) “In this position, ring assembly 19 is disposed in abutting engagement against stop members 45, thus assuring a secure attachment between assembly 19 and socket 25 which will not become accidentally loosened or disconnected during operation of motor 3.” (DJI-1007, 3:60-65.) Sokn further notes that “[i]t is of course possible to configure first and second engagement portions 35 and 47, and also stop members 45 in order to provide a predetermined orientation for the engagement and interlock connection between ring assembly 19 and socket 24.” (DJI-1007, 3:66-4:2.) To unmount (or disassemble), ring assembly 19 is rotated 90° in the opposite direction.

C. Motivation to Combine Sasaki and Sokn

106. Sokn's use of a plurality of protruding thread segments, rather than continuous threads, in combination with stop members 45 provides a secure interlock connection without the risk of overtightening. Specifically, the stop members prevent any further rotation of ring assembly after insertion. The use of directional threads allows for easy "mistake proofing" of the coupling. A POSITA would have been motivated to replace Sasaki's directionally threaded screw coupling mechanism with Sokn's modified threaded coupling mechanism.

107. Specifically, in the combined coupling mechanism, a POSITA would have been motivated to replace the screw shaft (74) formed at the top of Sasaki's rotating shaft (73) with Sokn's first engagement portion 35 provided on the outer peripheral surface of Sokn's external ring. The resulting portion of the coupling mechanism on the shaft includes a plurality of circumferentially spaced thread segments 37 and notches defined therebetween as illustrated in the Figure below. Additionally, a POSITA would have been motivated to replace Sasaki's nut buried "in the central portion of the propeller (1)" (socket) with Sokn's stop members 45 and second engagement portion 47. The resulting portion of the coupling mechanism on the propeller blade has plurality of helical thread segments 49 spaced forwardly of stop members 45 as illustrated in the Figure below.



Combination of Sasaki and Sokn

108. A POSITA would appreciate that Sokn's coupling components can be scaled down to use with Sasaki's quadcopter. The scaling of Sokn's coupling components is a matter of mechanical design well within the capabilities of a POSITA as of the earliest possible priority date of the '184 patent. A POSITA would recognize that scaling can be achieved by selecting the proper materials and tolerances for the parts. In addition, the feasible maximum lift of the Sasaki/Sokn coupling mechanism would be equivalent to the Sasaki coupling mechanism, provided the materials are the same and the total surface area of the engagement portions were the same. In general, a higher surface area could be achieved with

Sokn's coupling components with little added expense or added weight. In addition, larger surface area and choice of stronger materials could enable Sokn's coupling mechanism to achieve much higher lift capacity than Sasaki's coupling mechanism.

109. Sokn's thread segments 37 and corresponding notches of the shaft portion are helical. (See DJI-1007, 3:28-34.) Because Sokn's second engagement portion has a thread configuration corresponding to the first engagement portion 35, the thread segments 49 of the blade portion are also helical. (See DJI-1007, 3:45-47.) Sokn further teaches that the first and second engagement portions and stop members can be configured to provide a predetermined orientation for engagement and interlock connection. (DJI-1007, 3:66-4:2.) Based on this explicit teaching of Sokn and the teachings of Sasaki regarding directionality of threading in the clockwise and counterclockwise coupling mechanisms, a POSITA would have been motivated to orient the thread segments and corresponding notches for the clockwise coupling mechanism of the clockwise propeller in a left helical direction (similar to a left screw) as taught by Sasaki. (See DJI-1006, 2:5-8.) With this orientation, the rotation force during operation is in the locking direction. The stops prevent overtightening by restricting further rotation. The orientation further prevents disassembly during operation. Thus, in the combined UAV of Sasaki and Sokn, to couple the clockwise propeller to the shaft, the protruding thread segments 49 of the blade portion are placed in the notches between the thread segments 37 of

the shaft portion. The propeller is then rotated in a counterclockwise direction until the thread segments 37 engage stop members 45 of the blade portion.

110. Similarly, a POSITA would have been motivated to orient the thread segments and corresponding notches for the counterclockwise coupling mechanism of the counterclockwise propeller in a right helical direction (similar to a right screw) as taught by Sasaki. (See DJI-1006, 2:5-8.) Thus, in the combined UAV of Sasaki and Sokn, to couple the clockwise propeller to the shaft, the protruding thread segments 49 of the blade portion are placed in the notches between the thread segments 37 of the shaft portion. The propeller is then rotated in a counterclockwise direction until the thread segments 37 engage stop members 45 of the blade portion. Disassembly of Sokn requires rotation of the rotor blade in opposite direction of operation. The engagement portions in the combined system would then release like a screw but require fractional rotation rather than multiple rotations to fully disengage the components

111. A POSITA would have been motivated to modify the coupling mechanism of Sasaki to use the coupling mechanism of Sokn for a number of reasons. First, Sokn's coupling mechanism maintains the "mistake-proofing" of Sasaki's prior art directionally threaded screw fastener without suffering from overtightening. Sokn's use of a plurality of protruding thread segments, rather than continuous threads, in combination with stop members 45 provides a secure

interlock connection without the risk of overtightening. Specifically, the stop members prevent any further rotation of ring assembly after installation. In normal operation, the stop members resist all of the rotational force of the motor against the rotor blade while the helical thread engagement surface resists the lift and thrust forces. In this way, Sokn's connector used with Sasaki's driveshaft is not subject to overtightening.

112. Second, a POSITA would have been motivated to use Sokn's connection mechanism to provide increased design flexibility. Sokn's connection mechanism can be used with a wider range of aircraft than Sasaki's threaded connection. For example, if the size of the quadcopter increases, Sasaki's connection would require the size of the shaft and engaging surface to increase (*e.g.*, longer screw with greater diameter) to withstand the lift of quadcopter. Increased motor shaft diameter and length will increase relative weight which is a driving design factor of all aircraft. In addition, as rotor blades get larger, mounting them using Sasaki's threaded mechanism would be difficult to achieve without increased potential for "cross-threading" and damaging the mechanism. Cross-threading occurs when two treaded components are engaged without properly aligning the threads. The mis-aligned threads cut into each other and cause irreparable damage.

113. Third, a POSITA would have been motivated to use Sokn's locking mechanism to improve usability. As explained by Sokn, its locking arrangement provides a "large and easily alignable target area" so that ring assembly 19 (shaft lock portion) can be easily aligned and inserted with socket 25 (blade lock portion). When implemented in Sasaki's quadcopter, a user can assembly and disassemble the propellers with only $\frac{1}{2}$ turn as compared with 3-4 turns with the threaded connection disclosed in Sasaki. The improved efficiency is beneficial for quadcopter design, particularly because quadcopters are used outdoor, often in remote areas. Additionally, Sokn's connection mechanism has improved mechanical alignment. Sasaki's threaded connection is subject to cross-threading issue where the user misaligns the screw thread with the embedded nut threads. Cross-threading can damage the threads on the driveshaft which is often unrepairable. Sokn's lug/notch style (segmented threading) is easily aligned and does not have a cross-threading issue.

114. As discussed above, one of the issues addressed and claimed by the inventors of the '184 patent is the mechanism for a precision connection of a component (propeller) to a rotating component (driveshaft). This was not only a problem for multi-rotor copters such as the quadcopter but for any system requiring a precise and secure connection of one component to another component. Therefore, given the nature of the problem being addressed, a POSITA would have

consulted references describing coupling mechanisms for components requiring precise connections and would have been led to Sokn. Sokn stresses that its coupling mechanism provides “a precise alignment between the motor and the housing.” (DJI-1007, Abstract.)

D. Dependent Claims 3 and 4.

115. Challenged claims 3 and 4 each depend from independent claim 1. Before discussing how the combination of Sasaki and Sokn discloses the limitations of claims 3 and 4, I discuss how the combination of Sasaki and Sokn discloses the limitation of claim 1.

1. Claim 1

116. For ease of discussion, I have reproduced the limitations of claim 1 below with reference labels:

[1P] A rotary wing aircraft apparatus comprising:

[1A] a body;

[1B.1] a plurality of arms extending laterally from the body, and

[1B.2] a rotor assembly attached to an outside end of each arm;

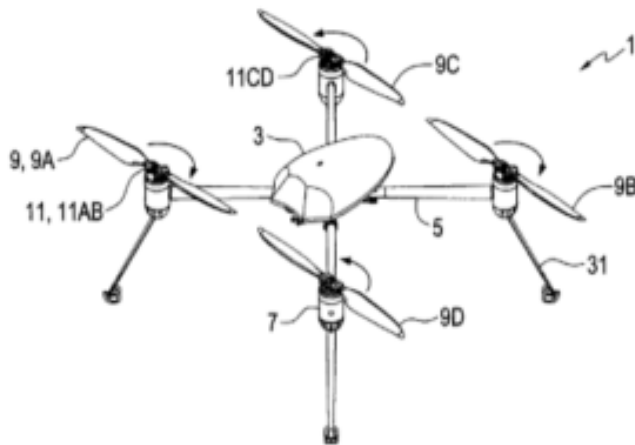
[1C] each rotor assembly comprising [1C.1] a rotor blade releasably attached to [1C.2] a driveshaft by [1C.3] a lock mechanism, and [1C.4] a drive rotating the driveshaft

- [1D] wherein a first driveshaft rotates in a clockwise direction and a second driveshaft rotates in a counterclockwise direction;
- [1E.1] wherein a clockwise rotor blade is releasably attached to the first driveshaft by engagement in a clockwise lock mechanism and [1E.2] generates a vertical lift force when rotated in the clockwise direction, and
- [1F.1] a counterclockwise rotor blade is releasably attached to the second driveshaft by engagement in a counterclockwise lock mechanism and [1F.2] generates a vertical lift force when rotated in the counterclockwise direction;
- [1G] wherein the clockwise rotor blade is engageable only with the clockwise lock mechanism and cannot be engaged in the counterclockwise lock mechanism, and
- [1H] the counterclockwise rotor blade is engageable only with the counterclockwise lock mechanism and cannot be engaged in the clockwise lock mechanism; and
- [1I] wherein the clockwise lock mechanism comprises a shaft lock portion attached to the first driveshaft and a blade lock portion attached to the clockwise rotor blade, the shaft lock portion defining notches configured to engage corresponding lugs on the blade lock portion.

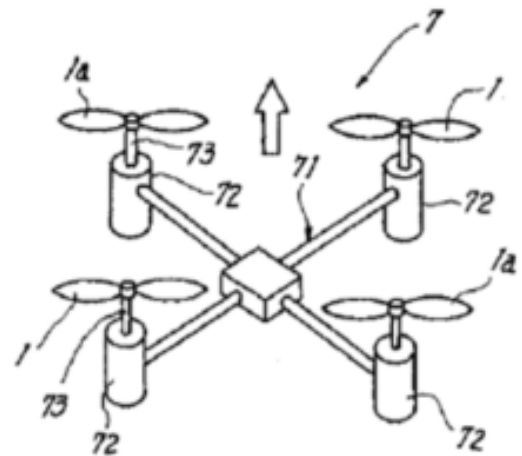
a. “A rotary wing aircraft apparatus comprising”

117. Figure 7 (reproduced below right) depicts Sasaki’s quadcopter (7) which Sasaki refers to as a “flying toy.” Sasaki’s quadcopter (7) has a similar

structure to the “rotary wing aircraft apparatus 1” of the ’184 patent as highlighted by the side-by-side comparison of Figure 7 of Sasaki (below right) and Figure 1 of the ’184 patent (below left).



'184 Patent, Figure 1

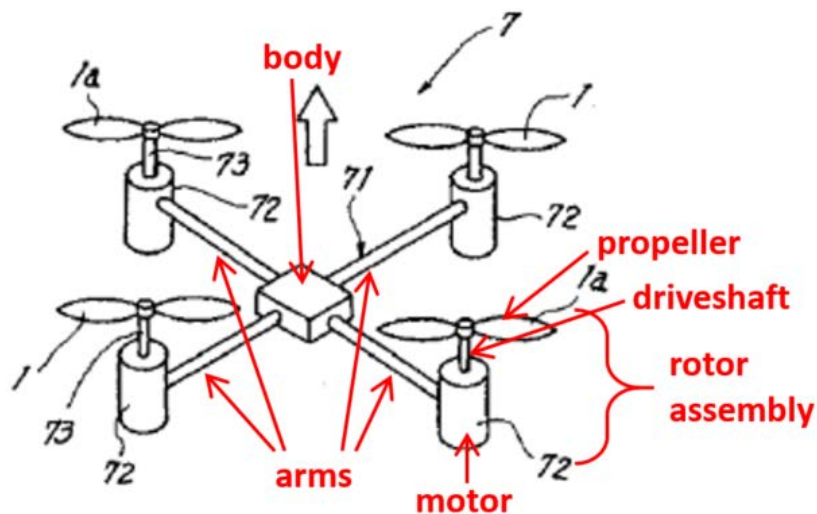


Sasaki, Figure 7

118. Sasaki’s quadcopter is a “*rotary wing aircraft apparatus*” [1P]. In Sasaki’s flying toy, “motors which are rotationally controlled by a pulse voltage are disposed independently of each other at four symmetrical positions around the flying toy body (71), and a propeller (1) is rotatably connected to each motor in a horizontal plane.” (DJI-1006, 4:3-7.) Sasaki explains that each propeller “has a plurality of wing pieces (23) integrally formed from a narrow mounting portion (21) of the central portion.” (DJI-1006, 4:36-39.)

b. “a body” and “plurality of arms”

119. Sasaki’s quadcopter (7) includes a body having four arms extending laterally from the body as illustrated in Figure 7 below. (See also, DJI-1006, 4:3-7.) Accordingly, Sasaki’s quadcopter includes “a body” [1A] and “a plurality of arms extending laterally from the body” [1B.1].



Sasaki, Figure 7

c. “a rotor assembly attached to an outside end of each arm”

120. In Sasaki’s quadcopter, motors 72 “are disposed independently of each other at four symmetrical positions around the flying toy body (71).” (DJI-1006, 4:3-6.) A propeller is “detachably attached to a top end of the upward **rotating shaft (73)** of the **motor (72)** by a fixture (4).” (DJI-1006, 4:27-29.) As shown in Figure 7 above, each of the four motors is coupled to a shaft 73 which is in turn coupled to a propeller. Although Sasaki does not use the term “rotor assembly,” a

POSITA would understand that a rotor assembly includes a motor, a driveshaft, and a propeller. As I discussed in detail in the Background section, “Design and Construction of a Quadrotor-type Unmanned Aerial Vehicle: Preliminary Results,” Section II.B, to Sa confirms the components of a rotor assembly. The ’184 patent acknowledges that a rotary assembly includes a rotor blade attached to a driveshaft which is driven by a motor. Thus, Sasaki discloses “*a rotor assembly attached to an outside end of each arm*” [1B.2].

d. “each rotor assembly comprising a rotor blade releasably attached to a driveshaft by a lock mechanism, and a drive rotating the driveshaft”

121. As discussed above, Sasaki’s quadcopter includes a rotor assembly attached to an outside end of each arm comprised of a propeller, a driveshaft and a motor. The term “propeller” is often used interchangeable with “blade” or “rotor blade.” Each of Sasaki’s propellers is the recited “*rotor blade*.” Sasaki discloses that each motor² in its rotor assembly “drives” the rotation of the driveshaft, explaining that each propeller “is **rotatably connected** to each motor.” (DJI-1006, 4:6-7.) Therefore, Sasaki’s rotating shaft (72) is the claimed “*driveshaft*” and motor (72) is the claimed “*drive rotating the driveshaft*.”

² The ’184 patent states that a drive is “typically an electric motor.” (DJI-1001, 3:20-21.)

122. Sasaki explains that “[t]he propellers (1) (1a) are each detachably attached to a top end of the upward rotating shaft (73) of the motor (72) by a fixture (4).” (DJI-1006, 4:27-29.) The “rotor assembly” of combined UAV of Sasaki and Sokn includes a connection mechanism (“*lock mechanism*”) having two portions—a portion located on the blade in the socket at the central portion of the propeller (“*blade lock portion*”) and a portion at the end of the rotating shaft (73) (“*shaft lock portion*”). The rotor blade is coupled to the driveshaft by engaging the two portions and rotating the propeller relative to the driveshaft as I discussed in detail in the section related to the combination of Sasaki and Sokn. The rotor blade is removed from the driveshaft by rotating the propeller in the opposite direction as I described above. Thus, the combination of Sasaki and Sokn discloses that “*each rotor assembly compris[es] a rotor blade releasably attached to a driveshaft by a lock mechanism.*”

e. “wherein a first driveshaft rotates in a clockwise direction and a second driveshaft rotates in a counterclockwise direction”

123. It was well-known that adjacent propellers in a quadrotor-type UAV such as disclosed by Sasaki rotate in opposite directions as discussed in the Technology Background section above. This well-known design is discussed in “Design and Construction of a Quadrotor-type Unmanned Aerial Vehicle: Preliminary Results” to Sa. The ’184 patent acknowledges that unmanned rotary

aircrafts with two clockwise rotating propellers and two counterclockwise rotating propellers were known prior to the earliest possible priority date of the '184 patent. (DJI-1001, 1:24-31, 3:31-37.) In addition, Sasaki teaches this well-known concept, explaining that “[o]ne group of propellers (1) facing diagonally rotates in the direction opposite to the direction of rotation of the other group of propellers (1a), and the reaction force occurring due to the rotation of each set of propellers (1) (1a) is canceled by one another so that the flying toy can fly.” (DJI-1006, 4:8-14.) Thus, Sasaki discloses “*wherein a first driveshaft rotates in a clockwise direction and a second driveshaft rotates in a counterclockwise direction*” [1D].

f. Lock Mechanism

i. Directional locking mechanism limitations.

124. As discussed above, Sasaki describes directional locking mechanisms. Specifically, Sasaki teaches that its clockwise propellers use a clockwise coupling (lock) mechanism and its counterclockwise propellers use a counterclockwise coupling (lock) mechanism. (DJI-1006, 2:5-8.) As discussed above, the combined UAV of Sasaki and Sokn uses modified threaded structure for the locking mechanism on its clockwise rotor blade/driveshaft and counterclockwise rotor blade/driveshaft. Specifically, in the combined system, the thread segments and corresponding notches are oriented in the same direction as the continuous thread of Sasaki. I discussed the orientation of the thread segment above in the section

describing the combination of Sasaki and Sokn. Therefore, the locking mechanism in the combined UAV uses a thread segments and notches in a left helical direction for the clockwise rotor blade/driveshaft and thread segments and notches in a right helical direction for the counterclockwise rotor blade/driveshaft. Thus, Sasaki teaches “*a clockwise rotor blade is releasably attached to the first driveshaft by engagement in a clockwise lock mechanism*” [1E.1] and “*a counterclockwise rotor blade is releasable attached to the second driveshaft by engagement in a counterclockwise lock mechanism*” [1F.1].

125. As I discussed in the claim construction section, Patent Owner contended in its Patent Owner Preliminary Response in IPR2019-00343 that “[b]ecause the ’184 patent claims and specification make clear that the shaft lock portion and blade lock portion must form a lock mechanism, the claims do not cover devices where these claim requirements are evaded or where additional components – other than the shaft lock portion and blade lock portion – serve the function of attaching the rotor blade to the driveshaft.” (DJI-1019, pp. 19-20.) The combination of Sasaki and Sokn discloses the “lock mechanism” limitations under Patent Owner’s narrow interpretation of the limitation because the combined device does not use components other than a shaft portion or blade portion to attach the rotor blade to the driveshaft.

126. Sasaki teaches that “[o]ne group of propellers (1) facing diagonally rotates in the direction opposite to the 10 direction of rotation of the other group of propellers (1a), and the reaction force occurring due to the rotation of each set of propellers (1) (1a) is canceled by one another so that the flying toy can fly.” (Sasaki, 4:8-14.) As I described in the Technological Background section, the rotating propellers generate lift. Thus, the combination of Sasaki and Sokn also discloses that the “*clockwise rotor blade ... generates a vertical lift force when rotated in the clockwise direction*” [1E.2] and the “*counterclockwise rotor blade ... generates a vertical lift force when rotated in the counterclockwise direction*” [1F.2].

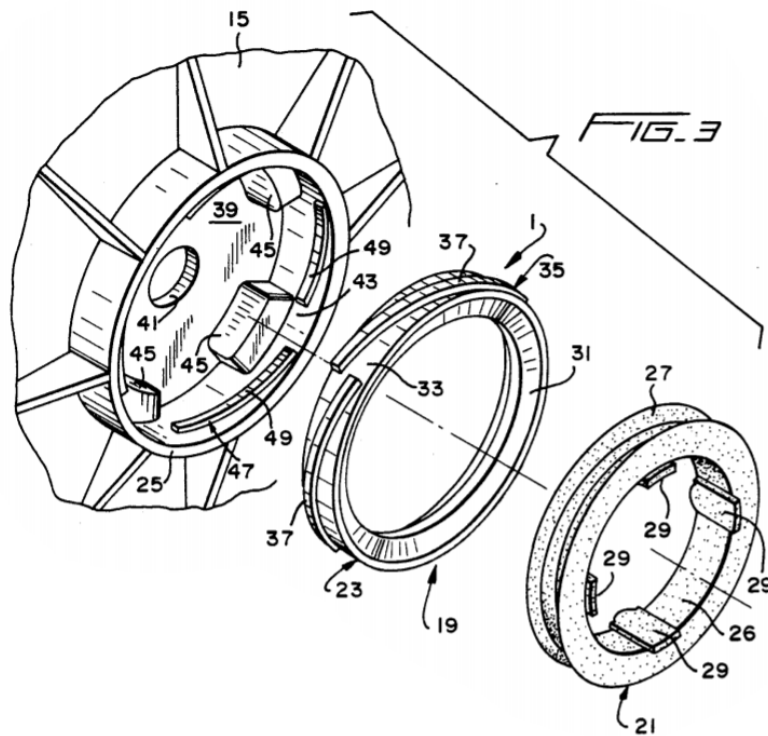
ii. “Keyed” connection

127. Sasaki teaches that the connections of its propellers to the driveshafts are keyed. Sasaki’s clockwise propellers use a clockwise lock mechanism—a left screw and associated nut. (DJI-1006, 2:5-7.) Thus, to couple the clockwise propeller to the base, the propeller is twisted in a counterclockwise direction. Sasaki’s counterclockwise propellers use a counterclockwise lock mechanism—a right screw and associated nut. (DJI-1006, 2:7-8.) To couple the counterclockwise propeller to the base, the propeller is twisted in a clockwise direction. Because of this directional threading, the clockwise propeller cannot be used on the counterclockwise driveshaft.

128. As described above, in the combined UAV of Sasaki and Sokn, the clockwise lock mechanism uses left oriented helical segments and notches and the counterclockwise lock mechanism uses right oriented helical segments and notches. Because the combined UAV retains the directional nature of the threading in Sasaki, the counterclockwise propeller cannot be used on the clockwise driveshaft. Thus, the combination of Sasaki and Sokn discloses that “*the clockwise rotor blade is engageable only with the clockwise lock mechanism and cannot be engaged in the counterclockwise lock mechanism*” [1G] “*and the counterclockwise rotor blade is engageable only with the counterclockwise lock mechanism and cannot be engaged in the clockwise lock mechanism*” [1H].

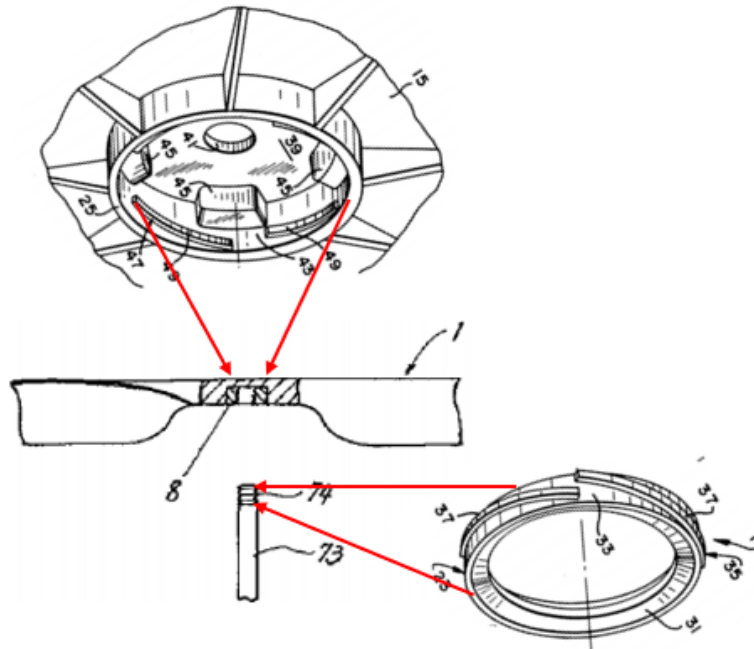
iii. Lug/notch limitations

129. In the combined UAV of Sasaki and Sokn, the screw shaft (74) formed at the top of Sasaki’s rotating shaft (73) is replaced with Sokn’s first engagement portion 35. The resulting structure at the end of the rotating shaft (73) is the claimed “*shaft lock portion attached to the first driveshaft.*” As illustrated in Figure 3 of Sokn below, the first engagement portion 35 includes a plurality of circumferentially spaced thread segments 37 and notches (indentations) defined therebetween.



130. In the combined system, Sasaki's nut buried "in the central portion of the propeller (1)" (socket) is replaced with Sokn's stop members 45 and second engagement portion 47. The resulting structure in the socket of the propeller is the recited "*blade lock portion attached to the ... rotor blade.*" The blade lock portion has plurality of protruding helical thread segments 49 spaced forwardly of stop members 45 as illustrated in Figure 3 below. Both the clockwise and counterclockwise lock mechanisms use a similar two-part arrangement; the core difference between the clockwise and counterclockwise lock mechanisms is the direction of the thread segments and notches. Thus, the combination of Sasaki and Sokn discloses that "*the clockwise lock mechanism comprises a shaft lock portion*

attached to the first driveshaft and a blade lock portion attached to the clockwise rotor blade.”



131. As illustrated in Figure 3 above, the first engagement portion (shaft lock portion) includes a plurality of helical thread segments 37 that define indentations/notches therebetween. The indentations between the thread segments 37 are the recited “notches.” The second engagement portion of the blade lock portion includes a plurality of protruding thread segments 49. The protruding thread segments 40 are the recited “corresponding lugs.” Sokn explains that the first engagement portion is aligned and inserted into the second engagement portion. (DJI-1007, 3:53-57.) Specifically, the lugs of the blade lock portion are aligned and inserted into the corresponding notches of the shaft lock portion. When insertion is

accomplished, the shaft lock portion is rotated relative to the blade lock portion, resulting in “a secure and aligned interlock connection” therebetween. (DJI-1007, 3:57-59.) The blade is twisted (rotated) in the direction required by the orientation of its threads until the thread segment of the shaft lock portion abuts against the stop of the blade lock portion. Thus, the combined UAV of Sasaki and Sokn discloses that “*the shaft lock portion defining notches configured to engage corresponding lugs on the blade lock portion.*”

2. Claims 3 and 4

132. As discussed above, the combined UAV of Sasaki and Sokn uses a clockwise lock mechanism with its clockwise propellers—specifically, left oriented helical thread segments and associated notches. (DJI-1006, 2:5-7.) Thus, to couple the clockwise propeller to the clockwise driveshaft, the propeller is twisted in a counterclockwise direction. To release the propeller, the rotor blade is rotated in the opposite direction of operation. The engagement portions would then release like a screw but require fractional rotation rather than multiple rotations to fully disengage the components. The combination of Sasaki and Sokn therefore discloses that “*the blade lock portion of the clockwise lock mechanism is rotated counterclockwise with respect to the shaft lock portion thereof to releasably attach the clockwise rotor blade to the first driveshaft*” as recited in dependent claim 3.

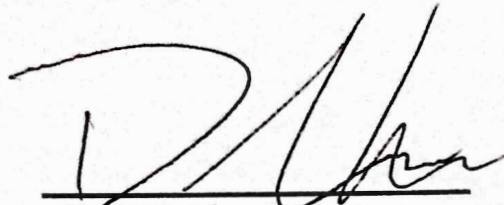
133. The combined UAV of Sasaki and Sokn also uses a counterclockwise lock mechanism with its clockwise propellers—specifically, right oriented helical thread segments and associated notches. (DJI-1006, 2:5-8.) To couple the counterclockwise propeller to the base, the propeller is twisted in a clockwise direction. To release the propeller, the rotor blade is rotated in the opposite direction of operation. The engagement portions would then release like a screw but require fractional rotation rather than multiple rotations to fully disengage the components. Therefore, the combination of Sasaki and Sokn also discloses that “*the blade lock portion of the counterclockwise lock mechanism is rotated clockwise with respect to the shaft lock portion thereof to releasably attach the counterclockwise rotor blade to the second driveshaft*” as recited in dependent claim 4.

IX. CONCLUSION

134. For the reasons set forth above, in my opinion, claims 3, and 4 of the '184 patent are rendered obvious.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Dated: March 19, 2019



Alfred Ducharme