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(54) **Title:** OPERATING METHOD FOR A CONVERTIBLE UAV

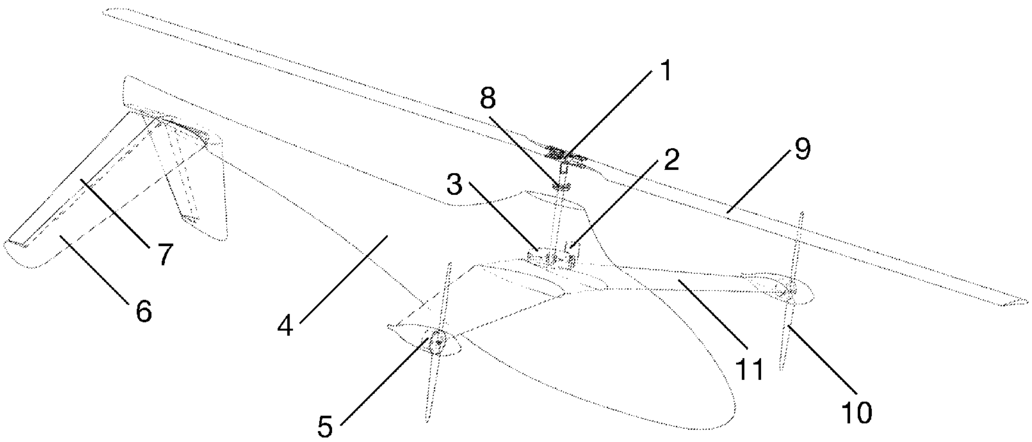

Fig. 1

(57) **Abstract:** The subject of the invention is an operating method for convertible aircrafts, in particular convertible UAVs, more specifically the method of transition from helicopter mode to gyroplane mode and vice versa. The subject of the invention also includes the UAV configured to perform said method, the aircraft being equipped with a fuselage (4), wings (11) attached to said fuselage (4), tail (6), swashplate (8), main rotor (9), and at least one propeller (10) and at least one motor (5) on each wing (11).

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Operating method for a convertible UAV

TECHNICAL FIELD OF THE INVENTION

The present invention relates to convertible aircrafts and the operating method of convertible aircraft(s), in particular convertible UAV(s) (UAV in the present specification stands for unmanned aerial vehicle), more specifically the method of transition from helicopter mode to gyroplane mode and vice versa.

BACKGROUND

Currently, there are two known aircraft solutions using rotary wings, i.e. the helicopter and the autogyro. For both aircrafts, the lifting force needed to fly is generated by the rotary wings. The two types are different in their method of driving and control. In a helicopter, the rotors are driven by a driving engine and control is exercised by a swashplate, which ensures that aerodynamic forces are generated on the rotors at the location and with the force that corresponds to the manoeuvre direction. The force generated by the tail rotor makes it possible to rotate around the axis and to compensate the torque created by driving the main rotors. In an autogyro, the aircraft requires movement speed, so that the rotors are rotated by the wind. Movement speed is produced by one or more traction or pushing engines. For autogyros, directed aerodynamic forces are generated by tilting the rotor head. In such a situation, the aerodynamic force generated on the tail surface, as control surface, produces rotation movement around the axis. These principles are fundamentally different, and, even though both have their specific advantages, no aircraft has been created ever before that would combine both systems in a highly efficient manner.

The state of the art includes the following solutions.

Chinese patent document No CN105923154 describes an aircraft that uses wings with double rotors, with propellers mounted onto the aircraft vertically and horizontally. The vertical propellers perform take-off and landing, and the horizonal propeller perform flying horizontally.

Chinese utility model description No CN202481309 describes an aircraft that is fitted with a vertical take-off and landing system controlled by autopilot. During take-off, the aircraft is supported by a propeller mounted on its tail, and horizontal flight is performed by two propellers mounted on the wings.

US patent document No US2002011539 describes a hovering gyrocopter that is capable of both fast horizontal flight and vertical take-off due to its propellers. The aircraft is also fitted with a flight-support stabilizer.

Spanish patent document No ES2359325 describes a system that can be installed on aircrafts and is capable of selecting the flight mode that is most suitable for the given circumstances from the helicopter, gyrocopter, and airplane modes available on the aircraft.

Chinese patent description No CN108750101 describes an unmanned aerial vehicle that is fitted with three different propeller systems. With these, the vehicle is capable of combining helicopter-like hovering with autogyro-like horizontal flight.

US patent documents Nos US2011024551, US2008294305, US2009321554, US2012153072, and US2010310371 describe aircrafts that combine the elements of an autogyro and a helicopter. The aircrafts may also be used as drones.

The solution described in US patent document No US2018072411 presents a procedure for using automatic auto-pilot controlled aircrafts that are fitted with both horizontally and vertically mounted propellers.

US patent documents Nos EP2690011, EP3141478, and US2011036954 describe aircrafts that combine the elements of an autogyro and a helicopter, and are capable of flying in both modes.

US patent document No US7918415, claiming priority over Spanish patent application No ES2275370A1, describes an aircraft is capable of applying the flight principles of a helicopter, a gyrocopter, and an airplane by selecting the corresponding flight mode. The solution applies to driving engines to drive the main rotor. The aircraft offers various solutions for stopping the main rotor and either setting it into a position that is parallel with the wings, in order to generate greater lifting force, or folding it back to reduce the resistance of the blades as much as possible. However, the rotor is never stopped using the solution according to this invention. Driving is provided by two internal combustion driving engines or turbines, which is another difference as the present invention uses an electric power source. Our invention also makes it possible to use purely electrical driving; if extra energy is required for certain applications, it is provided by a supplementary generator unit (that converts fuel into electricity with great efficiency) that supports the use of three, individually controlled electric motors (two driving engines and one main rotor engine). Another difference is that the present invention does not apply any servo movement solution to position the rotor blades relative to each other or the aircraft’s longitudinal axis, as they rotate continuously and in a fixed position relative to each other. Yet another difference is that the aircraft forming part of the state of the art has, according to the main claim, a landing gear, brakes, clutch, wings with ailerons, and a tail unit with rudders; also, the wings of the aircraft are capable of holding the weight of the aircraft. The typical implementation form of our present invention does not have any of these features.

SUMMARY

There is a need for a new, simple, light-weight, convertible UAV and operating method of the same that offers secure transition between helicopter mode and gyroplane mode; has low energy consumption and is capable of autorotating like gyrocopters; as well as hovering and taking of vertically like helicopters in spite of lacking a tail rotor.

The purpose of the invention is to eliminate the faults of known solutions and to create an UAV and an operating method for the same that has the advantages of both helicopters and gyrocopters, the UAV being able to fly both in helicopter and gyroplane mode securely, with separate controlling means.

The inventive step is based on the recognition that an invention that is more advantageous than the previous ones can be realized if the invention is implemented according to claim 1.

The traditional helicopter mode is fundamentally more economic than other multicopters or VTOL (Vertical Take-Off and Landing) aircrafts, as a helicopter has one driving engine and the lowest rotor wing loading, which means that it consumes the lowest amount of energy when carrying the same load. Efficiency increases as wing loading reduces. (In a multicopter, the total surface area of the rotor is always smaller than that of a single large rotor.) As the sizes increase, it becomes more and more difficult to control a multicopter, as regulation is based on changes in torque created by changing the rotary speed of the rotors, but this option is limited when using larger and heavier rotors. On the contrary, changing the position angle in a helicopter in a cyclical manner is fast, efficient, and independent of size. For this reason, we also use helicopter mode for hovering.

However, autogyro mode is used for horizontal flight, as such flight requires less energy in autogyro mode than moving in the same direction in helicopter mode. Unlike in conventional autogyros constructed so far, control is exercised in the solution according to the present invention aerodynamically, using the control surfaces mounted on the tail of the vehicle, as well as by changing the force of the traction or pushing engines for each engine individually. Characteristically, the swashplate is in a fixed position angle. The control surfaces on the tail, implemented as an inverted butterfly stabilizing fin, also perform the height and horizontal driving of the vehicle. During flight, it is also possible to compensate for the disorienting effect of the wind and to perform extreme manoeuvres (e.g. sharp and quick turn around the axis) by applying different loads on the traction or pushing engines.

As different controllers (control surfaces, servos) are required for the helicopter mode and the gyrocopter mode, a possible malfunction in a controller used for either mode does not affect the safe functioning of the other system. Thus, this solution offers a double, redundant operating method, thereby increasing the safe operation of the aircraft considerably.

According to the above purpose, the most general implementation form of the invention is described in claim 1. The individual implementation forms are described in the dependent claims.

The solution, in general, is an operating method for a convertible UAV configured to perform transition from helicopter mode to gyroplane mode and vice versa, said UAV being equipped with a fuselage, wings attached to said fuselage, tail, swashplate, main rotor, at least one propeller and at least one motor on each wing, and a control system; so that the UAV is driven by a main rotor engine and/or driving engines, and the UAV is controlled by a swashplate and/or control surfaces. A distinctive feature of the procedure is that it includes the following steps: the main rotor engine drives the main rotor, control is provided by a swashplate, and the driving engines generate thrust in the opposite direction to compensate for the torque of the main rotor; then, transition from helicopter mode to autogyro mode is performed, so that the performance of the driving engine creating the forward pointing component is increased, and the performance of the other driving engine is decreased, and the increasing forward thrust launches the UAV; then, the control system sets the UAV into a small angle and keeps it in that approximate position; the driving engines drive, and so move the UAV forward; control is taken over from the swashplate by the control surfaces;

the main rotor engine is stopped; and main rotor performs autorotation thereby providing lifting force; the rotary speed of the main rotor is monitored by the control system.

In another implementation form, the main rotor engine is switched back on when the rotary speed reduces.

In another implementation form, transition from autogyro mode to helicopter mode is performed after the main rotor engine is switched bank on, in the course of which the main rotor is driven by the main rotor engine, and control is continued by the swashplate, and the driving engines are used only to compensate for torque.

Another characteristic may be that the transition may be repeated any number of time(s) in any direction.

In another implementation form, the step of operating the main rotor engine and the swashplate is performed during take-off and/or hovering; height and side control is performed by the control surfaces while moving forward, and the main rotor engine is switched off.

Another characteristic may be that the main rotor engine is switched on during landing.

Another implementation form could be where the main rotor performs autorotation during landing, if the swashplate is damaged.

In another implementation form, the control surfaces and the swashplate perform control simultaneously, and the driving engine(s) and the main rotor engine drive simultaneously.

In another implementation form, the control surfaces are used for control, if the swashplate is damaged.

Another characteristic may be that the UAV is fitted with a battery where electric drive is used.

In another implementation form, the UAV is fitted with an internal combustion engine and a generator connected to the internal combustion engine; the generator monitors the charge in the battery, and the used electric power is replaced.

The UAV implementing the procedure includes, in general, a fuselage, a tail, wings mounted on the fuselage, and an autopilot control system; it includes a swashplate, a main rotor, a main rotor engine, and a rotor head; at least one driving engine and at least one propeller is mounted on each wing, the propeller is connected to a driving engine, and the tail is fitted with at least two control surfaces. A distinctive feature of the vehicle is that it has a free driving-gear, and the free driving-gear is connected to the main rotor and the main rotor engine; the tail is implemented as an inverted butterfly stabilizing fin.

A distinctive feature may be that the main rotor engine and the driving engines are electric motors, and the driving engines are traction or pushing engines.

In another implementation form, the vehicle is fitted with an internal combustion engine, which is connected to at least one battery through a connected generator, and the battery is connected to the main rotor engine and the driving engines.

Another distinctive feature may be that at least one control servo motor is connected to the control surfaces.

It should be emphasized that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. The words “autogyro”, “gyrocopter” and “gyroplane” are used as synonyms. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises", "comprising", "includes" and/or "including" when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The term "and/or" includes any and all combinations of one or more of the associated listed items.

Unless otherwise defined, all terms (including technical and scientific terms) used in present specification have the same meaning as commonly understood by a skilled person in the art to which this invention belongs.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment, albeit not an exclusive one, of the present invention is described in detail below. For a better understanding thereof, some illustrative drawings are attached, provided merely as an example and not limited thereto.

In said drawings:

Figure 1 shows a schematic spatial drawing of the UAV, also showing connections between the internal units,

Figure 2 shows a side view segment presenting the main rotor and its drive, and

Figure 3 shows a front view of the UAV.

DETAILED DESCRIPTION

Figure 1 shows a spatial image of the UAV. In this implementation form, the vehicle is fitted with a rotor head 1, a swashplate 8, a main rotor 9, a main rotor engine 2 capable of driving the main rotor 9, and a free driving-gear 3 connected to the main rotor 9. Two wings 11 and a tail 6 with control surfaces 7 are connected to the fuselage 4 of the the aerial vehicle shown on this Figure. The tail 6 is implemented as an inverted butterfly stabilizing fin and it is composed of two parts, with one control surface 7 on each side. Each wing 11 is fitted with at least one driving engine 5 and propellers 10 that can be driven by the driving engines 5. Depending on the operating mode, the driving engines 5 are responsible for producing the force needed to move the UAV (forward pursuant to the flight direction) and for compensating for the torque created by the rotating main rotor 9. The driving engines 5 are usually traction motors, but they may be implemented as pushing motors as well. In another possible implementation form, two or three etc. driving engines 5 are mounted on each wing 11. The propellers 10 are located at the end of each wing 11. The wings 11 are not fitted with any control surface, the aerial vehicle can navigate using the control surface 7 mounted on its tail 6. The control surfaces 7 are controlled by software, and they may be supported by a control servo solution. The control servo motor is controlled by the control system (autopilot). The servos are fitted with position transmitters, so that the control system (autopilot) is capable of verifying the execution of any deviation. Unlike in other aircrafts, the wings 11 are unable to carry the weight of the vehicle, but they produce some lifting force and provide stability. The vehicle does not have any brake or clutch, and there is no aileron on the wings. Unlike in helicopters, the vehicle is not fitted with any tail rotor. During the operation of the aerial vehicle, the main rotor 9 does not stop, and the rotary speed of the main rotor 9 is monitored by the control system (autopilot).

The autopilot control system controls the UAV, switches modes, and monitors the movements of the aerial vehicle using sensors. It adjusts individual components using servos. The control system has its own power supply, and the critical components, sensors, or even the autopilot module may have two-fold or even three-fold redundancy. (This is determined pursuant to the nature of the mission.) All parameters of the system (power, rotary speed, position, acceleration etc.) are measured and stored for subsequent analysis. The control system is also equipped with a telemetry module, which transmits important mission parameters to the operator and/or the ground control unit.

Thus, the vehicle is built in a redundant manner; it is fitted with two driving engines 5, which is an important part of its advanced safety. In the typical implementation form, both driving engines 5 and the main rotor engine 2 are electric. In the typical implementation form, the invention takes power from one or more battery or batteries, which is or are located inside the fuselage 4. If it is not possible to store sufficient power for the flight using electric driving only, the system may be supplemented with a supplementary power source comprising an internal combustion engine and a power generator connected to it. As such fuels have higher energy density at this time, they may be used to extend flight time, and using a smaller battery would also suffice. The generator monitors the voltage of the battery, and it replaces the power used as necessary. Thus, the internal combustion engine and the generator are optional parts, and they are not indicated on the drawing.

Figure 2 shows the side view of the main rotor 9 fitted with a rotor head 1. The drawing shows the swashplate 8, and a broken line indicates how the main rotor engine 2 is connected to the main rotor 9 through the free driving-gear 3 and an axis. It also shows the side wing 11 connected to the fuselage 4, the propeller 10 mounted on it, and the driving engine 5 driving the propeller 10, which is either a traction or pushing engine, but it is traction engine in this implementation form.

Figure 3 shows the front view of the aerial vehicle. The drawing shows the swashplate 8, the main rotor 9, the fuselage 4 and tail 6 of the vehicle, the side wings 11, and the propellers 10.

With regard to operation, the vehicle has two operating modes, a helicopter mode and an autogyro mode; the UAV can operate in either mode as well as by combining the two modes. Generally, helicopter mode is used for hovering, and autogyro mode is used for moving forward. The aerial vehicle is suitably used in helicopter mode for take-off and landing, and safety landing may also be performed in autogyro mode.

In helicopter control and lifting force producing mode, the main rotor 9 is driven by the main rotor engine 2, this makes the vehicle hover. In such a situation, control is exercised using the swashplate 8, and the two driving engines 5 are used to compensate for the main rotor 9 torque.

The other operating mode is the autogyro mode and autorotation, which mode is optimised for flying a path. In this process, aerodynamic control is used; to this end, the control surfaces 7 located on the tail 6 are used without driving by the main rotor 9. In this mode, the main rotor engine 2 is switched off, and the free driving-gear 3 ensures that the main rotor 9 keeps rotating freely once the main rotor engine 2 is stopped. Thus, unlike earlier inventions, the main rotor 9 is not stopped at all; on the contrary, it is kept in use in autorotation to produce lifting force. As the main rotor 9 is not driven, there is no torque that would require compensation, which is a considerable power saving factor. The vehicle is pulled forward by the driving engines 5. An electronic control system (autopilot) monitors the rotary speed of the main rotor 9, and if it drops below safe rotary speed (where the rotor rotary speed cannot produce sufficient lifting force, and the vehicle would commence an unplanned descent), the main rotor engine 2 switches back on automatically for assistance, thereby avoiding a loss in lifting force. In autogyro mode, the swashplate 8 is out of operation, and it interferes in extreme situations only. In this mode, the vehicle is capable of flying safely and without any other energy input by way of autorotation. (Remember that various helicopters are also capable of doing so, but in their case, the malfunction of a swashplate would result in an accident.) Each of the two driving engines 5 are suitable for flying safely, so having two also increases safety two-fold.

A combined mode is also possible at slow speed, where the main rotor engine 2 rotates the main rotor 9 to a minor extent only, and autorotation also contributes to the production of the lifting force required.

Transitioning between the two modes is a complex process, and it is managed, in both directions, by a precise control system automatically, using the autopilot. Transition between the two modes may be performed time and time again in a split second. For safety, both operating modes are functional individually as well. The special rotor head 1 is to keep the main rotor 9 blades flexibly in the position that is most suitable for autorotation. Thus, the main rotor 9 is set into that position automatically if the servos supporting the swashplate 8 malfunction for any reason, and the UAV executes emergency landing in autogyro mode.

The design of the rotor head 1 differs from that of a helicopter, as the rotors of a helicopter are easy to rotate, and it also differs from that of an autogyro, as the blades of an autogyro are connected to the rotor head in a fix angle.

Transitioning is executed as follows: the vehicle begins to hover in helicopter mode, and it elevates to the appropriate height and position. In this mode, the two driving engines 5 produce thrust in the opposing direction to compensate for the torque generated by the rotating main rotor 9. When transitioning begins, the driving engine 5 producing the forward-driving component starts pulling with greater performance, while the driving engine 5 on the other side needs to produce less force to compensate, so the aerial vehicle begins to move forward due to the increasing forward-driving component. The sensors of the autopilot system monitor and adjust the vehicle's horizontal position, so that the vehicle is kept in a small angle position continuously, thereby ensuring air flow that is required for autorotation. Height is set by the autopilot by adjusting the swashplate 8, so that the main rotor 9 blades produce only as much lifting force as necessary to maintain height. The main rotor 9 rotates with a permanent rotary speed. This is ensured by the main rotor engine 2 controller. Naturally, the rotor plane thus set to a position angle produces a minor backward aerodynamic force component, but it is overcome by the driving engines 5. When a suitable speed is reached, the air flow can rotate the main rotor 9 at full speed, so that the main rotor engine 2 can be switched off. The aerial vehicle is controlled pursuant to its flight mode (using the swashplate 8 or the control surface 7 located on the tail 6); both modes are active during transition, they are controlled by software in proportion to the transition status.

The modes may be switched in an automatic manner; for example in the two scenarios explained as follows: when the rotary speed of the main rotor 9 drops below the safe level in autogyro mode (e.g. an extreme manoeuvre is executed, and it slows down the rotor due to an unexpected large angle position), the main rotor engine 2 is switched on, and the autopilot control switches the aerial vehicle into helicopter mode if necessary. Another example is that the aerial vehicle switches to autogyro mode, if the swashplate 8 control malfunctions in helicopter mode. Altogether, flight mode is switched in a situation when the autopilot has confirmed and verified by various means that it is unable to comply with instructions in the current mode. In such an event, the vehicle keeps flying, returns home, or executes emergency landing as necessary in light of the extent of malfunction.

The invention described above has numerous advantages. An advantage of the invention is that the aerial vehicle is constructed in a redundant manner, meaning that its two-fold secured (e.g. the malfunction of any given system component during flight does not result in an accident), and it is a highly efficient aerial vehicle consuming a small amount of energy. During flight, increased safety is guaranteed by the fact that the vehicle has two independent systems, and the possible complete or partial malfunction of either of those systems would not result in an accident. Safety is further increased by the fact that the aerial vehicle can fly safely in either operating mode, or even in a combined mode. The vehicle can keep flying and land safely even if the swashplate is damaged, and it is also capable of flying in a stable manner even if an engine is out of operation. Another advantage of the invention is that the vehicle can be controlled by aerodynamic means only, when autogyro mode is used. Another advantage is that, in autogyro mode, the control surfaces perform vertical and horizontal control over the vehicle, due to the design of the control surfaces. As the stabilizing fin is implemented as an inverted butterfly, the air flow coming from the rotor causes less resistance or vibration. (Note that vibration is a considerable problem for drones.) Another advantage is that the vehicle can be driven by electric power only, so that it is quiet and safe for the environment.

Although particular features have been shown and described, it will be understood that they are not intended to limit the claimed invention, and it will be made obvious to those skilled in the art that various changes and modifications may be made without departing from the scope of the claimed invention. The specification and drawings are, accordingly to be regarded in an illustrative rather than restrictive sense. The claimed invention is intended to cover all alternatives, modifications and equivalents.

CLAIMS

1. Operating method for a convertible UAV configured to perform transition from helicopter mode to gyroplane mode and vice versa, said UAV being equipped with a fuselage (4), wings (11) attached to said fuselage (4), tail (6), swashplate (8), main rotor (9), at least one propeller (10) and at least one driving engine (5) on each wing (11), a control system,
so that the UAV is driven by a main rotor engine (2) and/or driving engines (5), and the UAV is controlled by a swashplate (8) and/or control surfaces (7),
characterized in that the operating method comprises the following steps
the main rotor engine (2) drives the main rotor (9), control is provided by a swashplate (8), and the driving engines (5) generate thrust in the opposite direction to compensate for the torque of the main rotor (9);
then, transition from helicopter mode to gyroplane mode is performed, so that the performance of the driving engine (5) creating the forward pointing component is increased, and the performance of the other driving engine (5) is decreased, and the increasing forward thrust launches the UAV;
then, the control system sets the UAV into a small angle and keeps it in that approximate position;
the driving engines (5) drive, and so move the UAV forward;
control is taken over from the swashplate (8) by the control surfaces (7);
the main rotor engine (2) is stopped;
the main rotor (9) performs autorotation thereby providing lifting force;
the rotary speed of the main rotor (9) is monitored by the control system.

2. The procedure according to claim 1, **characterized in that** the main rotor engine (2) is switched back on when the rotary speed reduces.

3. The procedure according to claim 2, **characterized in that** transition from autogyro mode to helicopter mode is performed after the main rotor engine (2) is switched back on, in the course of which the main rotor (9) is driven by the main rotor engine (2), and control is continued by the swashplate (8), and the driving engines (5) are used only to compensate for torque.

4. Any of the procedures according to claims 1 to 3, **characterized in that** the transition may be repeated any number of times in any direction.

5. Any of the procedures according to claims 1 to 4, **characterized in that** the step of operating the main rotor engine (2) and the swashplate (8) is performed during take-off and/or hovering; height and side control is performed by the control surfaces (7) while moving forward, and the main rotor engine (2) is switched off.

6. Any of the procedures according to claims 1 to 5, **characterized in that** the main rotor engine (2) is switched on during landing.

7. Any of the procedures according to claims 1 to 6, **characterized in that** the main rotor (9) performs autorotation during landing, if the swashplate is damaged.

8. Any of the procedures according to claims 1 to 7, **characterized in that** the control surfaces (7) and the swashplate (8) perform control simultaneously, and the driving engines (5) and the main rotor engine (2) drive simultaneously.

9. Any of the procedures according to claims 1 to 8, **characterized in that** the control surfaces (7) are used for control, if the swashplate (8) is damaged.

10. Any of the procedures according to claims 1 to 9, **characterized in that** the UAV is fitted with a battery where electric drive is used.

11. The procedure according to claim 10, **characterized in that** the UAV is fitted with an internal combustion engine and a generator connected to the internal combustion engine; the generator monitors the charge in the battery, and the used electric power is replaced.

12. Convertible UAV configured to perform transition from helicopter mode to gyroplane mode and vice versa according to claim 1,
which includes a fuselage (4), a tail (6), wings (11) mounted on the fuselage (4), and an autopilot control system;

the UAV is equipped with a swashplate (8), a main rotor (9), a main rotor engine (2), and a rotor head (1);
at least one driving engine (5) and at least one propeller (10) is mounted on each wing (11), the propeller (10) is connected to a driving engine (5), and the tail (6) is fitted with at least two control surfaces (7),
characterized in that it has a free driving-gear (3), and the free driving-gear (3) is connected to the main rotor (9) and the main rotor engine (2); the tail (6) is implemented as an inverted butterfly stabilizing fin.

13. The vehicle according to claim 12, **characterized in that** the main rotor engine (2) and the driving engines (5) are electric motors, and the driving engines (5) are traction or pushing engines.

14. The vehicle according to claim 12 or 13, **characterized in that** it is fitted with an internal combustion engine, which is connected to at least one battery through a connected generator, and the battery is connected to the main rotor engine (2) and the driving engines (5).

15. Any of the vehicles according to claims 12 to 14, **characterized in that** at least one control servo motor is connected to the control surfaces (7).

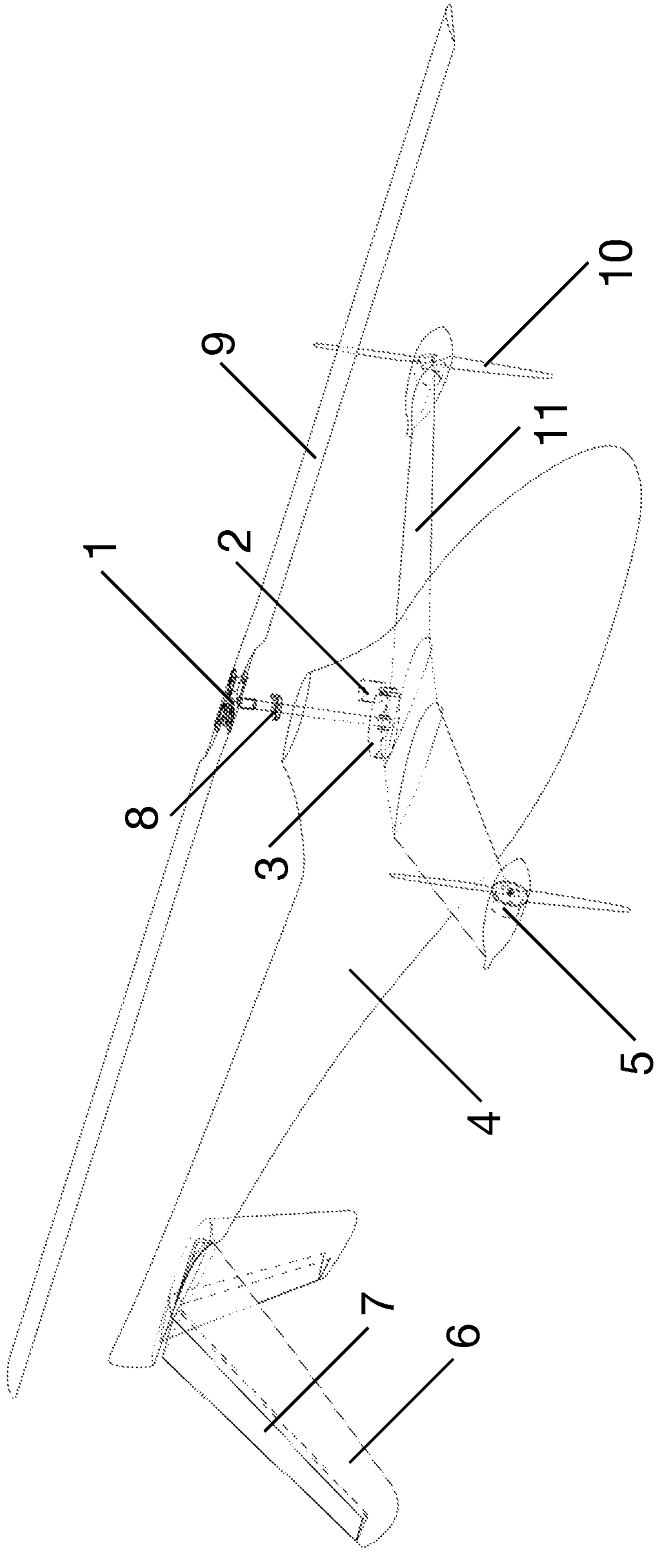

Fig. 1

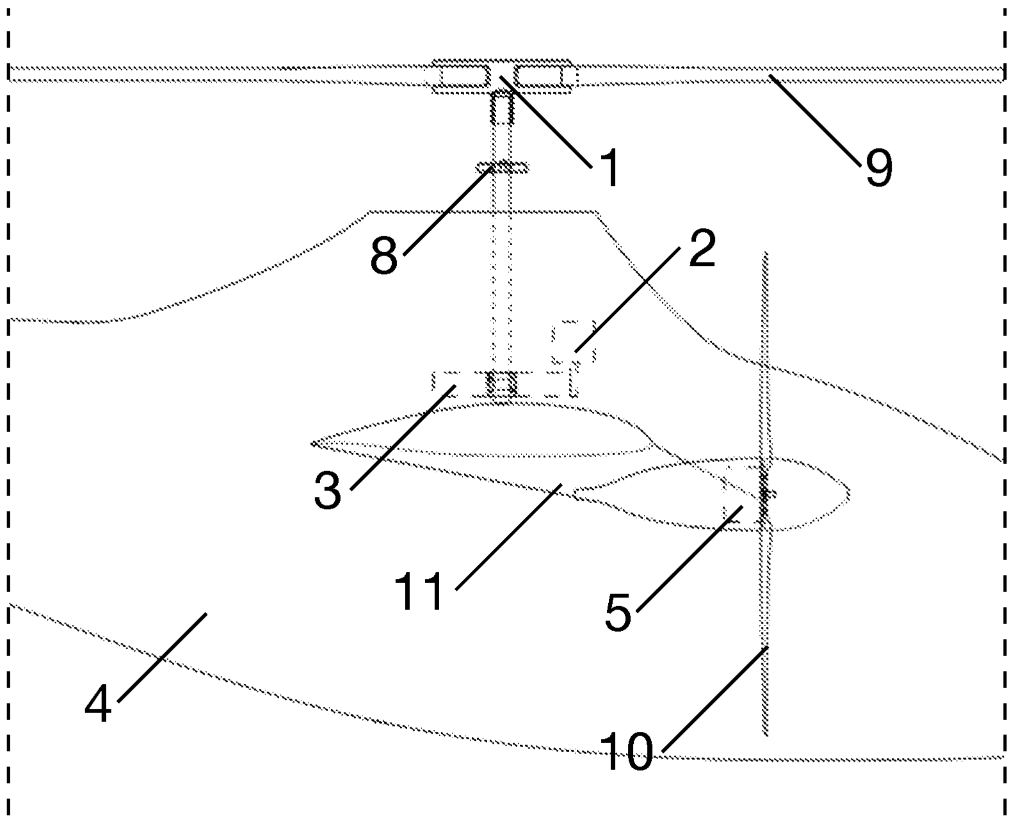

Fig. 2

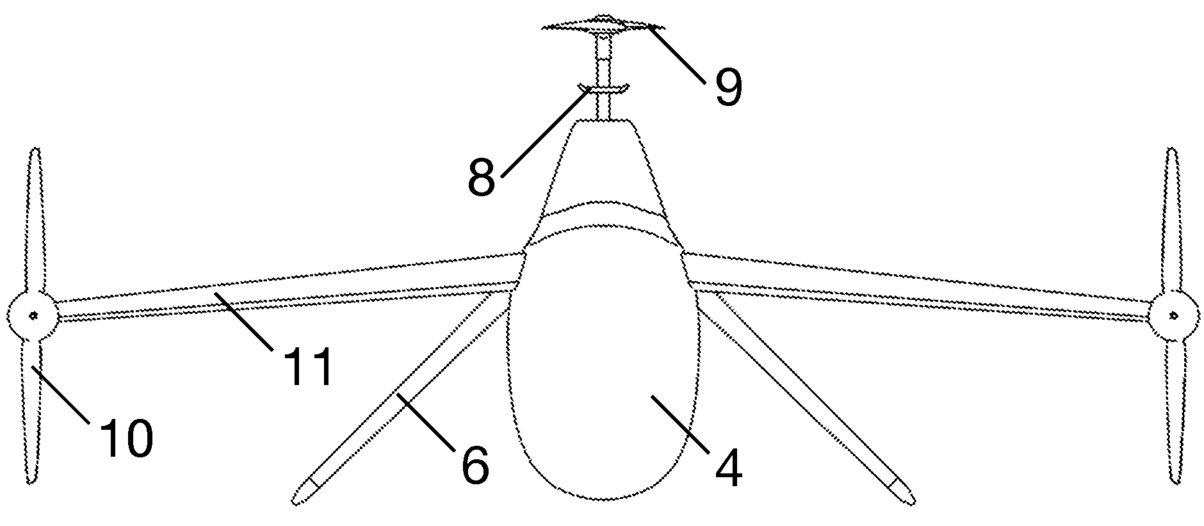

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/054910

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C27/26 B64C27/02 B64C27/605 B64C27/82 B64C5/02
B64C39/02 B64D27/24
ADD. B64D27/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B64C B64D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2002/011539 A1 (CARTER JAY W [US]) 31 January 2002 (2002-01-31) cited in the application paragraphs [0013] - [0020], [0024] - [0029], [0030], [0031]; figures 1-3	1-9,12 10,11, 13-15
Y	DE 20 2017 106992 U1 (SCHOPPE DEV UG [DE]) 30 November 2017 (2017-11-30) the whole document	10,11, 13-15

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2020	21/02/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Dorpema, Huijb

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SCOTT W B: "LARGE MARKET PREDICTED FOR HAWK 1 GYROPLANE", AVIATION WEEK AND SPACE TECHNOLOGY, MCGRAW-HILL COMPAGNY, NEW YORK, NY, US, vol. 137, no. 11, 14 September 1992 (1992-09-14), page 61, XP000285006, ISSN: 0005-2175 Middle column, 3rd bullet point -----	12
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2019/054910

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