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(54) Title: AN ELECTRIC DRONE GLIDER ARRANGEMENT

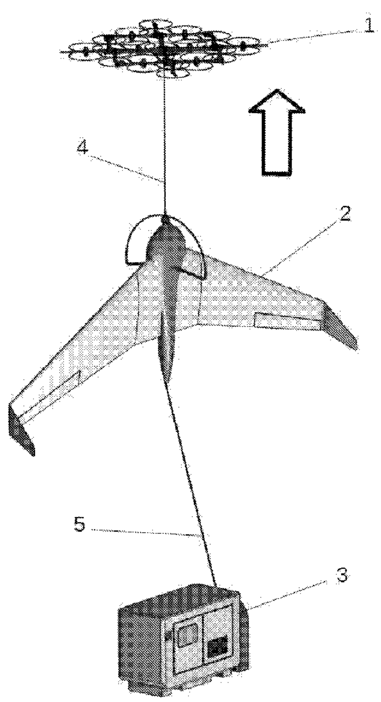

Fig. 1

(57) Abstract: The invention relates to electric drones and gliders. The electric drone glider arrangement comprising: a heavy-lift multi-rotor drone with batteries; a manned or unmanned glider; a high voltage generator; an electric cable and rope connecting the drone and the glider; an electric cable and rope connecting the glider and the generator. The cable and rope connecting the glider and the generator being detachably attached to the glider, such that the cable and the rope can be disconnected from the glider once the glider is raised to the sufficient height. The cable and rope connecting the glider and the drone has adjustable length and at both ends is connected to the center of gravity of the drone and the glider.

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An electric drone glider arrangement

Field of the Invention

The invention relates to electric drones and gliders.

Prior Art

Vertical take-off and landing vehicles, such as rotorcrafts, are typically more efficient during take-off and landing, than during horizontal flight. While fixed-wing aircrafts are more energy efficient during horizontal flight using moving air to gain and maintain height as well as glide.

There are known vertical take-off and landing winged aircrafts with pivoting rotors (US 9694911 B2, WO2015/143093, WO2017/210595) trying to solve the problem of energy efficiency and possibility of take-off and landing within limited area. The known devices allow to use advantage of a rotorcraft during vertical take-off and landing and advantage of a glider during horizontal flight.

To have efficient take-off and landing stages vertical air flow is necessary. In stages 2, 3 and 4 Glider needs horizontal air flow to reach beyond stall speed and gain lifting power. Transition stages requires both air flows that do not match. However, the known solutions create compromises by using some part of the device area for vertical air flow and some for horizontal. As a result, vertical lifting efficiency is low because of relatively small available propeller disk area and stall speed of the winged aircraft is high also because of relatively small wing size and worsened aerodynamics affected by vortices created between both air flows.

Disclosure of the Invention

The invention provides a manned or unmanned electrically powered flying arrangement with capabilities of vertical take-off or landing (VTOL) and efficient horizontal flight. Thereby the invention improves efficiency of the known devices by creating interactive dynamic system that allows to increase relative propeller disk area, separate air flows during transition stages between vertical and horizontal flight stages and optimize overall aerodynamics.

The electric drone glider arrangement comprising: a heavy-lift multi-rotor drone with batteries; a manned or unmanned glider; a high voltage generator (preferably, located on the ground); an electric cable and rope connecting the drone and the glider (said cable and rope having adjustable length); an electric cable and rope connecting the glider and the generator. The cable and rope connecting the glider and the generator being detachably attached to the glider, such that the cable and the rope can be disconnected from the glider once the glider is raised to the sufficient height. The cable and rope connecting the glider and the drone at both ends is preferably connected to the center of gravity of the drone and the glider.

Brief Description of Drawings

Fig. 1 shows a schematic view of the electric drone glider arrangement in take-off stage of the flight;

Fig. 2 – a schematic view of the electric drone glider arrangement in transition flight stage between vertical and fully horizontal flight stages;

Fig. 3 - a schematic view of the electric drone glider arrangement in horizontal (forward) flight stage.

Detailed Description of the Invention

The electric drone glider arrangement comprising:

- a heavy-lift multi-rotor drone 1 with batteries;
- a manned or unmanned glider 2;
- a high voltage generator 3;
- a cable and rope 4 connecting the drone 1 and the glider 2; the cable and rope 4 is provided with mechanism (e.g. winch) adapted to allow controllable adjustment of length of the cable and rope 4 during the flight of the drone glider arrangement;

- a cable and rope 5 connecting the glider 2 and generator 3; the cable and rope 5 being removably attached to the glider 2.

The detachable end of the cable and rope 5 connected to the glider 2 is preferably provided with a parachute designed to be deployed after the detachable end of the cable and rope 5 is disconnected from the glider 2 and falls down.

The electric drone glider 2 arrangement further optionally comprises solar panels mounted on the glider 2. In that case the electric cable connecting the drone 1 and the glider 2 can be used to send power to the drone 1 motors during horizontal stage of the flight.

The drone 1 can have coaxial propeller setup. Bottom propellers can be folded during horizontal stage of the flight to reduce drag. The drone 1 coaxial propeller setup can have bigger pitch value for top propellers and smaller pitch for bottom propellers so that better efficiency is achieved during the horizontal stage of the flight, providing still enough stability and lift during vertical take-off and landing stages.

The drone 1 is designed in a way that every motor has its own battery and they are connected in series and/or parallel so that high voltage electricity from the generator 3 can be utilized with almost no added weight.

The electric drone glider arrangement is preferably designed so that in an emergency situation the drone 1 can be disconnected from the glider 2 (i.e. the cable and rope 4 connecting the glider 2 and the drone 1 may be detached) and the glider 2 would be able to land as ordinary glider without VTOL capability.

The drone 1 is preferably designed so that it may be forced to stop all motors and deploy one or more parachutes.

The cable and rope 4 connecting the glider 2 and the drone 1 at both ends is connected to the center of gravity of the drone 1 and the glider 2. The rope 4 is preferably connected to the glider 2 and the drone 1 using roller guidance systems (e.g. curved rail roller track) where center of roller guidance system of the drone 1 is located in the center of gravity of the drone 1 and the center of roller guidance system of the glider 2 is located in the center of gravity of the glider 2. The roller guidance systems are adapted to allow free partial rotation of the drone 1 and the glider 2 around their center of gravity.

The electric drone glider arrangement has five stages of flight: vertical take-off, transition from vertical to horizontal flight, horizontal flight, transition from horizontal flight to vertical landing and vertical landing.

During the first stage (Fig. 1) the drone 1 takes off and gains altitude. When the height equal to cable and rope 4 height is reached, the drone 1 starts to lift the glider 2 in the air. The glider 2 wing might be pointed vertically up to increase efficiency. The generator 3 is providing power to the drone 1 motors through the cable 5 (from the generator 3 to the glider 2) and further on through the cable 4 (from the glider 2 to the drone 1 motors) so that the drone 1 batteries are not discharged during take-off. The cable and rope 4 is adjusted short for the glider 2 to have rotating capacity using its ailerons.

Once sufficient height is achieved the cable and rope 5 connecting the glider 2 and the generator 3 is disconnected from glider 2 and falls to the ground (preferably, with small parachute). The drone 1 stops gaining altitude, tilts and starts gaining horizontal speed. As speed increases the glider 2 wing turns from pointing upwards to pointing forward (Fig. 2). When stall speed for the glider 2 is exceeded the drone 1 continues to tilt forward and starts to lose altitude relative to the glider 2. At one point the drone 1 and the glider 2 are both at the same height. The rope 4 connecting the drone 1 and the glider 2 is never loose. As horizontal speed increases even more and stall speed is exceeded for the glider 2 to carry the drone 1 weight, then the drone 1 tilts more to fully vertical position. The cable and rope 4 connecting the drone 1 and the glider 2 is adjusted long enough so that vertical air flow of the drone 1 and horizontal air flow for the glider 2 do not affect each other.

When the drone 1 is positioned fully vertically (Fig. 3), its propellers are pulling it directly forward. Bottom propellers can be folded during this stage of the flight to reduce drag. The glider 2 relative position is above and behind the drone 1. All weight of the drone 1 is carried by the glider 2 with the rope 4 connecting the drone 1 and the glider 2. This is efficient flight stage because the glider 2 wing takes all weight and electric power is used only to give horizontal pull. Aerodynamics of the glider 2 and the drone 1 are made to reduce drag as much as possible. The cable and rope 4 at this stage is adjusted so that it does not create unnecessary aerodynamic drag during horizontal flight.

The next stage of the flight happens similar to stage two, only in reverse. When approaching landing a speed is gradually reduced until the glider 2 is not able to carry the drone 1 weight. The drone 1 starts to tilt backwards and gain height relative to the glider 2. When the drone 1 is above the glider 2, the speed is reduced even more until the glider 2 stalls. The cable and rope 4 connecting the drone 1 and the glider 2 is adjusted long enough for the same reasons as for the second stage of the flight.

The landing stage is similar to the take-off stage only in reverse and there is no cable and rope 5 connecting the glider 2 and generator 3. The drone 1 slowly looses altitude and brings the glider 2 to the ground. Then it keeps descending and lands itself. The cable and rope 4 connecting the drone 1 and the glider 2 might be adjusted short for this stage.

Claims

1. An electric drone glider arrangement comprising: a heavy-lift multi-rotor drone (1) with batteries; a glider (2); a high voltage generator (3); a cable and rope (4) connecting the drone (1) and the glider (2); a cable and rope (5) connecting the glider (2) and generator (3), wherein the cable and rope (5) connecting the glider (2) and generator (3) is removably attached to the glider (2); the cable and rope (4) connecting the glider (2) and the drone (1) is provided with mechanism adapted to allow controllable adjustment of length of the cable and rope (4) during the flight of the drone glider arrangement; wherein at both ends the rope (4) is connected to the center of gravity of the drone (1) and the glider (2).

2. The electric drone glider arrangement according to claim 1, wherein the end of the cable and rope (5) connected to the glider (2) is provided with a parachute designed to be deployed after the detachable end of the cable and rope (5) is disconnected from the glider (2).

3. The electric drone glider arrangement according to claim 1, wherein the glider (2) is further provided with solar panels.

4. The electric drone glider arrangement according to claim 1, wherein the drone (1) has coaxial propeller setup, wherein top propellers have bigger pitch value than pitch value of the bottom propellers.

5. The electric drone glider arrangement according to claim 1, wherein the drone (1) is designed in a way that every motor has its own battery and they are connected in series and/or parallel.

6. The electric drone glider arrangement according to claim 1, wherein the electric drone glider arrangement is designed so that in an emergency situation the cable and rope (4) connecting the glider (2) and the drone (1) may be detached.

7. The electric drone glider arrangement according to claim 1, wherein the rope (4) is connected to the glider (2) and the drone (1) using roller guidance system adapted to allow free partial rotation of the drone 1 and the glider 2 around their center of gravity.

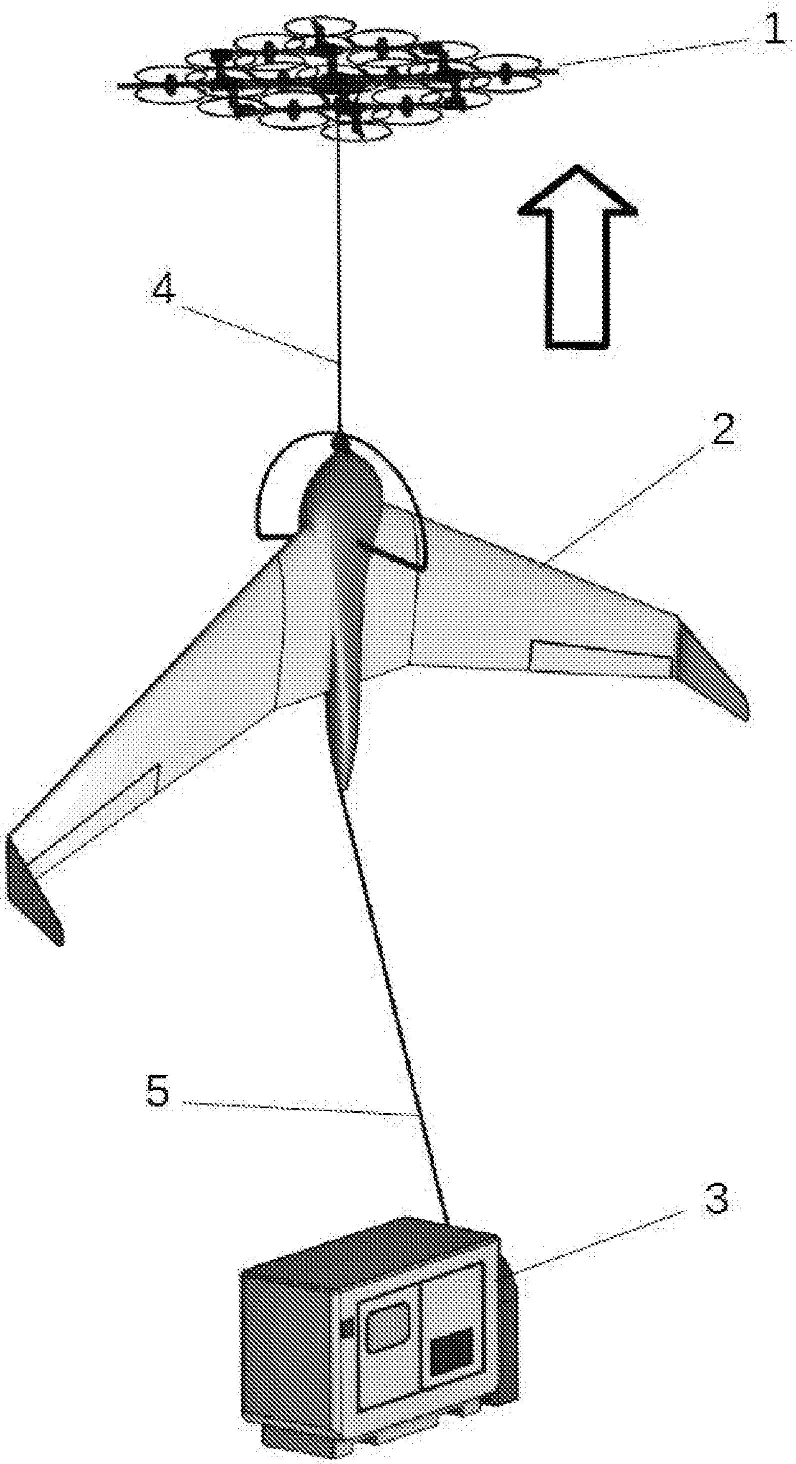

Fig. 1

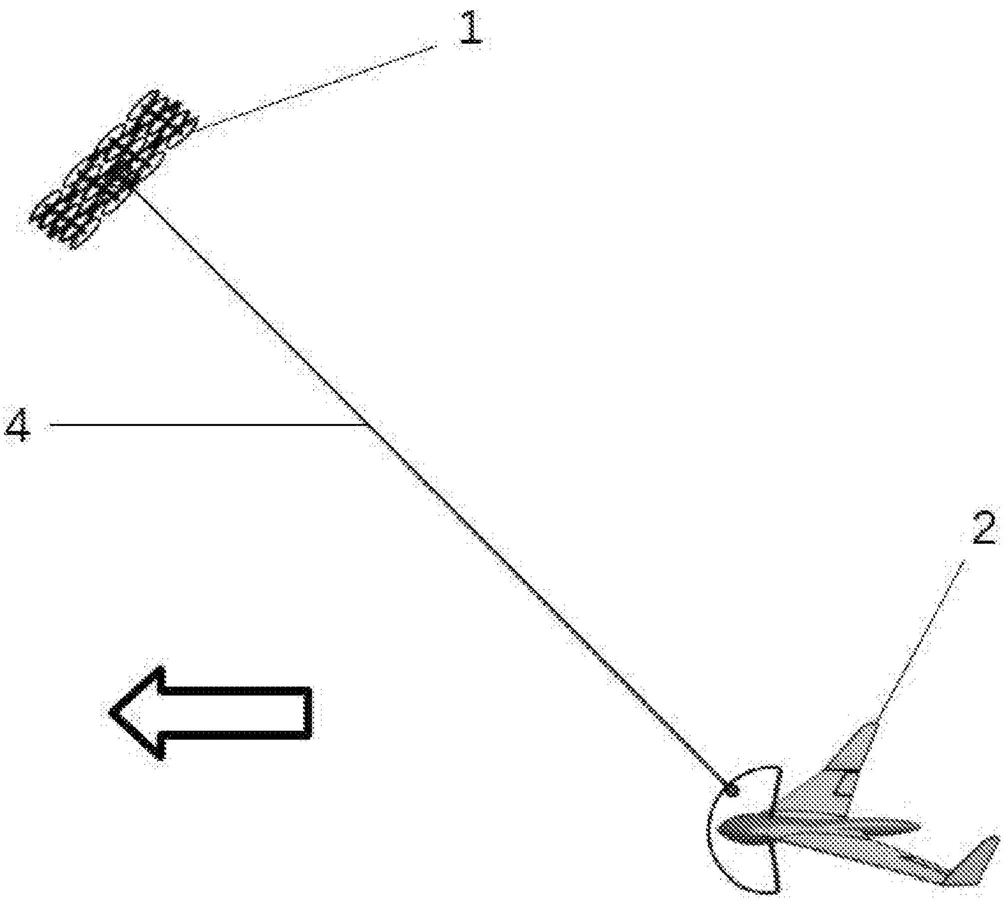

Fig. 2

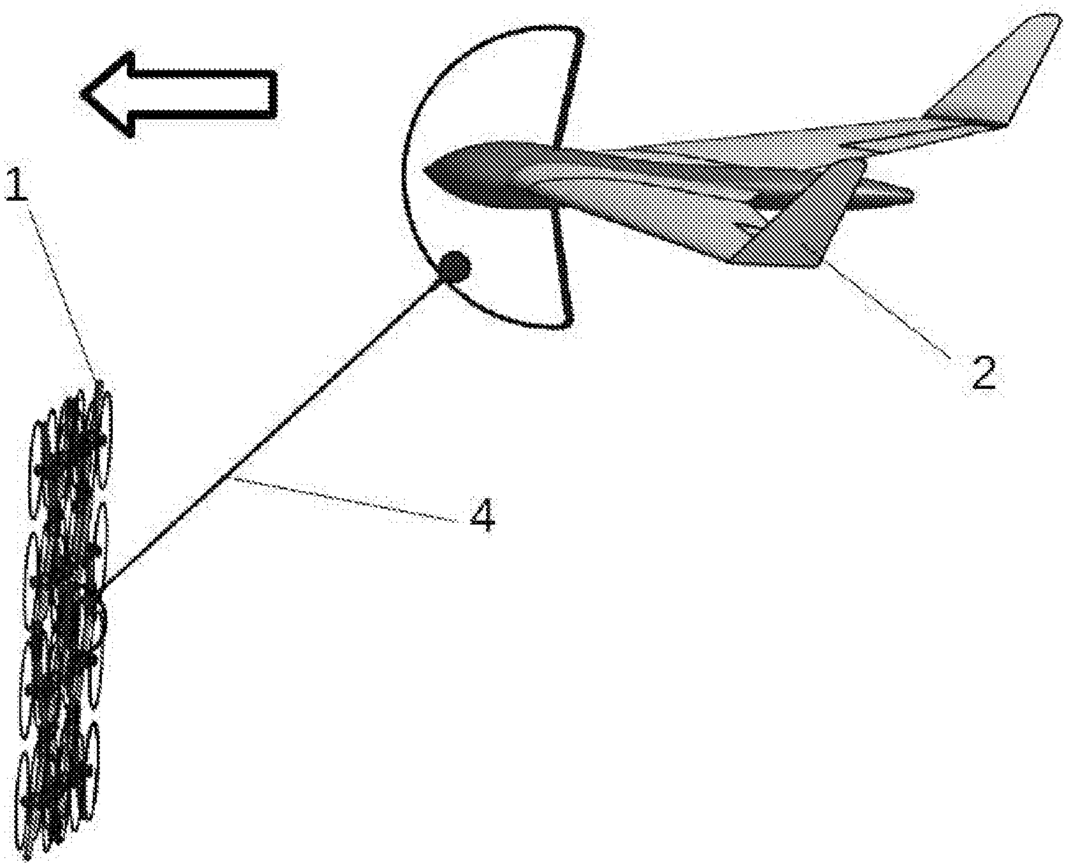

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/050313

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C29/00 B64C39/02 B64C31/02
ADD.

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

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.
A	WO 2007/141795 A1 (ISRAEL AEROSPACE IND LTD [IL]; BARNEA ELIEZER [IL]) 13 December 2007 (2007-12-13) abstract; figures -----	1-7
A	WO 2004/106156 A1 (QINETIQ LTD [GB]; KELLEHER CHRISTOPHER CHARLES [GB]) 9 December 2004 (2004-12-09) abstract; figures -----	1-7
A	US 9 457 900 B1 (JONES KEVIN D [US] ET AL) 4 October 2016 (2016-10-04) abstract; figures -----	1-7
A	WO 2013/178776 A1 (LOGO TEAM UG HAFTUNGSBESCHRAENKT [DE]) 5 December 2013 (2013-12-05) abstract; figures -----	1-7
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/050313

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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