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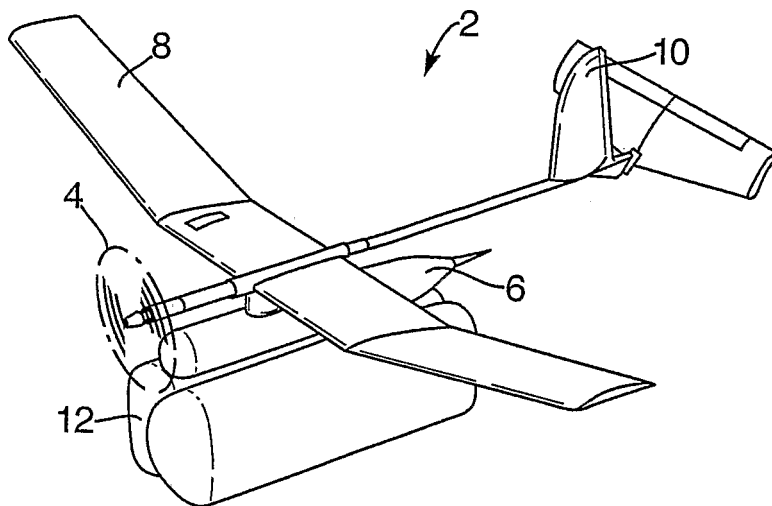
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(54) Title: UNMANNED AIR VEHICLES AND METHOD OF LANDING SAME



(57) Abstract: There is provided an Unmanned Air Vehicle (uav) (2) including an engine (4) and an airframe (6), including means for performing a deep stall manoeuvre; at least one inflatable sleeve (12) connected or connectable to the airframe (6), and means for inflating the sleeve (12) during flight, wherein the inflated sleeve (12) extends along the lower side of the airframe (6) so as to protect same during deep stall landing. A method for operating an Unmanned Air Vehicle (UAV), including an engine and an airframe is also provided.



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## **UNMANNED AIR VEHICLES AND METHOD OF LANDING SAME**

### **Field of the Invention**

The present invention relates to unmanned air vehicles and more particularly to the structure of an unmanned air vehicle and a method of landing it.

### **Background of the Invention**

While launching such Unmanned Air Vehicles (UAV) is carried out in conventional manners either by means of a runway on which the UAV is propelled to gain sufficient launching speed, or is launched from a base or a short elevated runway or even from an operator's hand, the landing thereof is more problematic and requires greater sophistication and unique techniques.

There are known in the art several methods of landing UAV's. The classic landing is on the vehicle's wheels along a runway. Similar landings are effected with vehicles equipped with skids, sledges or even with reinforced airframes, all necessitating runways or flat clear stretches of land. The per-se known deep stall technique can be applied to any of the above aircraft landing concepts/techniques and equipment, in a manner similar to that used when landing on the aircraft skids, sledges or airframes.

Utilizing the deep stall landing technique is, however, problematic in that the UAV is subject to severe jolts and accelerations on impact with the ground, often causing damage to the vehicle's structure and its rather sensitive payload, thus severely limiting the number of times that a single vehicle can safely be reused without repair. Furthermore, even with the deep stall technique, the landing terrain must always be carefully chosen, since rough terrains are unsuitable for this purpose.

### **Disclosure of the Invention**

It is therefore a broad object of the present invention to ameliorate the disadvantages of the deep stall landing techniques of UAV's and to provide a more reliable protection to the vehicle's payload and integrity.

It is a further object of the present invention to provide a UAV structure facilitating a reduced strike impact during deep stall landing.

It is still a further object of the invention to provide a UAV capable of deep stall landing also on rough terrains.

In accordance with the invention, there is therefore provided an Unmanned Air Vehicle (UAV) including an engine and an airframe, comprising means for performing a deep stall manoeuvre; at least one inflatable sleeve connected or connectable to said airframe, and means for inflating said sleeve during flight, wherein the inflated sleeve extends along the lower side of said airframe so as to protect same during deep stall landing.

The invention further provides a method for operating an Unmanned Air Vehicle (UAV), including an engine and an airframe, comprising providing means for performing a deep stall manoeuvre; at least one inflatable sleeve connected or connectable to the airframe, said sleeve extending along at least a portion of said airframe and means for inflating said sleeve during flight, and performing a deep stall landing of the UAV on said sleeve and inflating said sleeve.

The invention still further provides an airframe for an Unmanned Air Vehicle (UAV), comprising an airframe body; at least one inflatable sleeve; means for connecting the sleeve to said airframe, and means for inflating the sleeve during flight of the UAV.

The term UAV and airframe should be understood as including a flying wing type UAV in which there is no conventional tail and the fuselage may be integrated into the wing structure. The term airframe denotes any structural member of the UAV, such as fuselage, wing, tail assembly, etc.

### **Brief Description of the Drawings**

The invention will now be described in connection with certain preferred embodiments with reference to the following illustrative figures, so that it may be more fully understood.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred

embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

In the drawings:

Fig. 1 is an isometric view, to a reduced scale, of a UAV according to the present invention during landing, and

Fig. 2 is an isometric view of a sleeve and a UAV airframe according to the present invention;

### **Detailed Description of Preferred Embodiments**

There is illustrated in Figs. 1 and 2 a UAV 2 having an engine 4, an airframe 6, wings 8 and a tail assembly 10. The above-described UAV parts may be at least partly integral or assembled in-situ. The engine may be an electric or fuel-operated engine. Further seen is a sleeve 12, advantageously made of durable fabric, attached to the airframe 6. The sleeve 12 may take any desired configuration, e.g., may be substantially prismatic, cylindrical, or as shown, composed of two elongated portions wider than the width of the airframe 6, and advantageously, projecting from the front end of the airframe, when inflated. The sleeve 12 may be integrally connected to the lower surface of the airframe 6, or, alternatively, may be coupled thereto by connecting means provided on both the sleeve and the airframe. In a modification, the sleeve 12 may be provided with means, such as straps and/or hooks, which can be utilized before take-off when preparing the UAV for flight.

There is further provided means for inflating the sleeve during flight. Such means may be realized by, per-se known inflating devices such as electrically operated fluid pumps, blowers, electric fans, pressurized fluid containers or explosive charges equipped with remotely activating devices. Inflating the sleeve can be accomplished by utilizing ram air effect during flight and/or descent, thus not requiring an energy consuming

source on board of the UAV to provide the pressurized air required to inflate the sleeve. The ram air pressure may be created by the converging air intake according to the well-known design characteristics of a ram-jet engine. A controllable valve is actuated to let the air flow into the sleeve.

The UAV is further provided with means, including a remotely operable servo-mechanism for effecting a deep stall manoeuvre. Upon actuation of the servo-mechanism, the level control ailerons are made to assume a low or negative angle-of-attack, introducing an abrupt moment resulting in the nose or front end, and, in fact, of the entire air vehicle, to assume an upward direction. The angle-of-attack of the vehicle wings is likewise abruptly changed. Due to the predetermined relationship between the size of the level control ailerons and the winds, the air vehicle performs a deep stall manoeuvre.

The operation of UAV is as follows:

Once the airframe 6 is equipped with the inflatable sleeve 12 and means for inflating it during flight, the UAV is operated in common modes.

Upon preparing the UAV for landing, a deep stall landing manoeuvre is performed and the sleeve 12 is then inflated during flight, resulting in an abrupt landing while protecting the vehicle and payload from damage during impact with the ground. The sleeve 12 in its deflated state, stored in the airframe 6 is first being released through an openable hatch, door or doors from the airframe, while inflating it by any of the above-described means. The sleeve 12 may be inflated to a desired degree in consideration with the vehicle's weight, the weight of the payload, the type of terrain in which the vehicle is to be landed, etc. Upon landing, the inflated sleeve 12 first hits the ground, attenuating the impact. The sleeve 12 may then be deflated, checked for possible damage and rearranged on the same or another airframe for the next flight. Also the level control ailerons are rotated back to their normal flight disposition. Since the usage of such a sleeve 12 with a UAV facilitates landing by deep stall even on rough terrains,

without or with minimal damage to the vehicle and/or the vehicle's payload, the vehicle may be ready for its further mission within a very short period of time.

It will be evident to those skilled in the art that the invention is not limited to the details of the foregoing illustrated embodiments and that the present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

**WHAT IS CLAIMED IS:**

1. An Unmanned Air Vehicle (UAV) including an engine and an airframe, comprising:
  - means for performing a deep stall manoeuvre;
  - at least one inflatable sleeve connected or connectable to said airframe, and
  - means for inflating said sleeve during flight,
  - wherein the inflated sleeve extends along the lower side of said airframe so as to protect same during deep stall landing.
2. The UAV as claimed in claim 1, wherein said airframe is an elongated tubular body having a front end and a rear end.
3. The UAV as claimed in claim 1, wherein said sleeve, when inflated, assumes a configuration of at least one elongated tube.
4. The UAV as claimed in claim 1, wherein said sleeve, when inflated, assumes a configuration of two juxtaposed cylinders.
5. The UAV as claimed in claim 2, wherein said sleeve, when inflated, projects beyond the front end of the airframe.
6. The UAV as claimed in claim 1, wherein said means for inflating the sleeve are selected from the group of electrically operated air pumps, blowers, fans, pressurized fluid containers, explosive charges, or ram-air effect air intakes.
7. The UAV as claimed in claim 6, wherein said means for inflating the sleeve are equipped with automatic actuatable devices.
8. The UAV as claimed in claim 1, further comprising means for attaching said sleeve to the airframe.
9. The UAV as claimed in claim 1, wherein said airframe is provided with an openable hatch or door and said sleeve is retained in its deflated state, within said airframe.
10. The UAV as claimed in claim 1, wherein said means for effecting said deep stall manoeuvre include a remotely operable servo-mechanism.

11. A method for operating an Unmanned Air Vehicle (UAV), including an engine and an airframe, comprising:

providing means for performing a deep stall manoeuvre; at least one inflatable sleeve connected or connectable to the airframe, said sleeve extending along at least a portion of said airframe and means for inflating said sleeve during flight, and

performing a deep stall landing of the UAV on said sleeve and inflating said sleeve.

12. The method as claimed in claim 11, further comprising the step of deflating the sleeve after landing.

13. The method as claimed in claim 12, further comprising the step of inserting said sleeve into the airframe for further use.

14. The method as claimed in claim 12, further comprising the step of detaching the sleeve from the airframe and checking the sleeve for possible damage.

15. An airframe for an Unmanned Air Vehicle (UAV), comprising:

an airframe body;

at least one inflatable sleeve;

means for connecting the sleeve to said airframe, and

means for inflating the sleeve during flight of the UAV.

16. The airframe as claimed in claim 15, wherein said means for connecting the sleeve to the airframe are disconnectable means.

17. The airframe as claimed in claim 15, wherein said airframe is an elongated tubular body having a front end and a rear end.

18. The airframe as claimed in claim 15, wherein said airframe is furnished with at least one openable hatch or door.

19. The airframe as claimed in claim 15, wherein said sleeve, in its deflated state, is disposed inside said airframe.

20. The airframe as claimed in claim 15, wherein said sleeve, when inflated, assumes a configuration of at least one elongated tube.



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21. The airframe as claimed in claim 17, wherein said sleeve, when inflated, projects beyond the front end of the airframe.
22. The airframe as claimed in claim 15, wherein said means for inflating the sleeve are selected from the group of electrically operated air pumps, blowers, fans, pressurized fluid containers, explosive charges or ram-air effect air intakes.
23. The airframe as claimed in claim 15, wherein said means for inflating are equipped with automatic actuatable devices.

Fig.1.

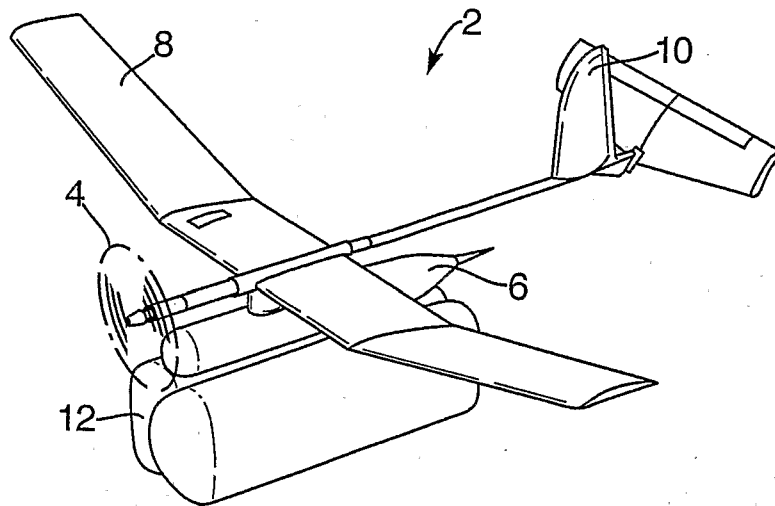
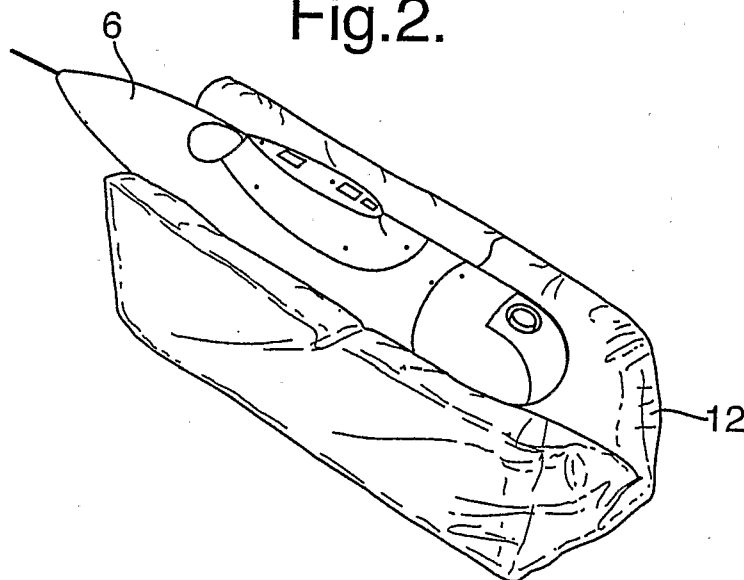


Fig.2.



A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B64C39/02

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)  
IPC 7 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 practical, search terms used)

EPO-Internal

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X	US 5 560 568 A (SCHMITTE ET AL) 1 October 1996 (1996-10-01) column 5, line 13 - line 20 column 6, line 27 - line 36 figure 1 -----	15-20, 22, 23 1-14, 21
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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