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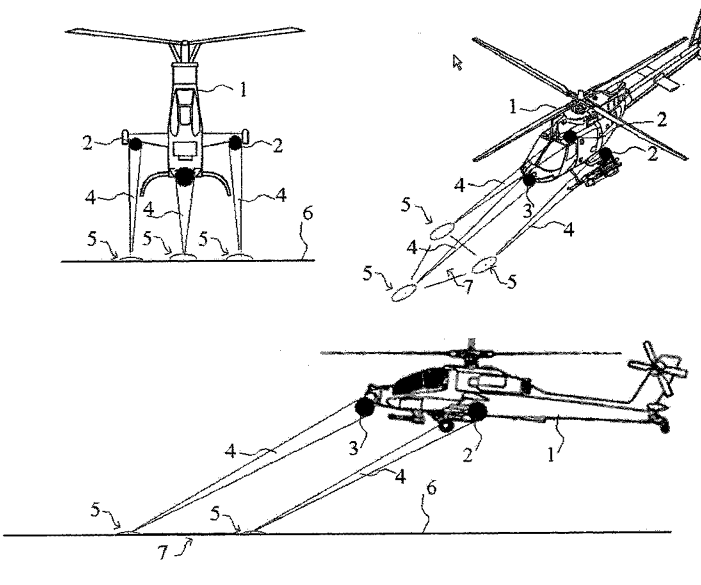
(54) Title: AIRCRAFT VEHICLE



(57) **Abstract:** Aircraft vehicle (1), comprising one or more light emitting devices (2,3) arranged to emit a converging light beam (4) which intersect (5) at a predetermined level (6) below the aircraft vehicle. Each light-emitting device may comprise e.g. two or three light beam sources, e.g. lasers. Two light emitting devices (2) may be mounted on either side of the aircraft vehicle (1), while a third light-emitting device (3) may be mounted in front or behind the imaginary connection line between said two light emitting devices (2) on either side of the vehicle. The light emitting devices preferably are arranged to emit said converging light beam at the predetermined level below the aircraft vehicle within an area (7) in front of the vehicle which visible for the vehicle's crew.

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Title: Aircraft vehicle

Field of the invention

The invention concerns an aircraft vehicle, e.g. a helicopter, and a configuration of light sources for facilitating its landing which may be hampered by atmospheric obscurants like snow ("white-out") or dust ("brown-out").

Background of the invention

Navigation and landing support systems are described for example in USP 2,532,104, USP 2,017,692 and GB 510,495.

USP 2,532,104 describes a light apparatus for aerial navigation comprising a first set of rear light sources that project mutually parallel beams in a controllable direction. In addition a second set of fixed light sources project a beam in a downward and converging direction.

USP 2,017,692 describes a landing light for airplanes. The landing light comprises a inner and an outer pair of lamps. The inner pair of lamps project substantially parallel beams extending downwardly with respect to the longitudinal axis of the plane. The outer pair of lamps project mutually intersecting light beams that also intersect the parallel beams at a distance larger than the distance at which the outer pair of beams intersect each other.

GB 510,495 describes a landing light system for an aircraft comprising pairs of lights mounted at the ends of the wings of the aircraft. Light beams coming from lights mounted at mutually opposite ends intersect at a predetermined location below the aircraft.

A more recent navigation support system is described in USP 5,315,296. This document discloses a cueing light configuration wherein a plurality of mutually non-intersecting light-beams is projected from multiple sources located on an aircraft to form two clusters. The pattern of each cluster changes as the aircraft flies above and below a predetermined nominal altitude. The initial patterns are two horizontal, spaced apart lines. Each is capable of changing to a delta formation as either the altitude or the terrain varies. The direction of the delta cues the pilot as to the direction of corrective action. This facilitates low level flying over hilly terrains etc. A disadvantage of this system is that interpreting the dot configuration is very much a cognitive process that needs to be learned.

During the day the sight of aircraft vehicle (e.g. helicopter) pilots may be hampered by atmospheric obscurants like snow (white-out) or dust (brown-out); at night, using NVG's – "Night Vision Goggles", eye-wear allowing to see in the dark – this typically is impossible. This is in first instance caused by the limited NVG field-of-view and the poor contrast of image intensification tubes. The limited resolution, the speckle noise, and the absence of color contribute to the poor visibility with NVG's. The increasing importance of military NVG operations in desert areas makes brown-out support increasingly important.

In order to aid the pilot in navigation under these circumstances, US 6,028,624 provides a landing system that comprises a first and the second laser mounted on a left wing and a right wing of the aircraft respectively. The emissions from these lasers is chopped such that alternatively a camera on the right wing will observe the terrain in front of the vehicle illuminated by the laser on the left wing and a camera on the left wing observes the terrain illuminated by the laser on the right wing. The cameras are provided with narrow bandpass filters that only pass light emitted by the lasers. In addition the runway where the aircraft is to be landed is provided with specular reflection devices spaced along each side. A computer system computes a stereoscopic representation from the data obtained by the cameras using filtering and other operations.

Summary of the invention

It is a purpose of the present invention to provide an aircraft vehicle that allows the pilot to make a full judgment of height, roll and pitch, in an intuitive way, using relatively simple means.

Accordingly the aircraft vehicle of the invention comprises light emitting devices each of them being arranged to emit a converging light beam or a set of converging light beams which intersect at a predetermined level below the aircraft vehicle, comprising two of said light emitting devices being mounted on either side of the aircraft vehicle and comprising a third light emitting device, mounted in front or behind the imaginary connection line between said two light emitting devices on either side of the vehicle.

The invention is based on the understanding that in principle it is possible to heads-out judge the distance to the ground surface and the vehicle roll through brown-outs and white-outs with a limited number of (e.g. IR) lasers mounted at (e.g. underneath) the vehicle. By mounting two sets of lasers side-by-side, the helicopter's “roll” becomes visible as the asymmetry between the two sets. Drift is the result of a helicopter roll; the two-set configuration therefore also provides (indirect) information about drift. Similarly the pitch is made visible by adding a third set of lasers pointing farther in front of the helicopter.

The preferred geometry is as follows. Each light-emitting device comprises two or more (preferably three) lasers. The beams of two or more (preferably three) lasers are mounted to intersect at a specified distance, here we take 5 meters as example. The positioning of the lasers is not critical; they may be mounted in each others vicinity (e.g. 30 cm separation) out to very far apart: e.g. underneath the left and right helicopter “wing”. The point of intersection should be in the pilots view, below and preferably in front of the helicopter. As long as the helicopter is farther than e.g. 5 meters from the ground surface, the intersection is visible beyond which the beams diverge until they reach the surface. At the surface each beam ends in a bright spot. When the distance is less than 5 meters, the beams have an abrupt ending without intersecting each other. When the atmospheric obscurant is too dense, the beams disappear gradually without ending in a bright spot. The distance to the surface is unknown but a minimum distance may still be judged.
The beams sources (e.g. lasers) may originate from nearby locations (e.g. 30 cm apart) or may originate from opposite ends of the aircraft vehicle. For example, the left wing/side may contain two lasers, viz. one shining straight down and the other shining to the point 5 meters below the right wing. And symmetrically the right

wing/side may contain two lasers, one shining straight down and the other shining to the point 5 meters below the left wing. The larger the mutual separation distance between the lasers within one co-operating set, the larger the height and therefore roll accuracy.

Preferably, however, the light beam sources of a light-emitting device are arranged in each other's vicinity, e.g. at a distance not more than 50 cm, e.g. 30 or 40 cm. It is recognized by the inventor that when the lasers are arranged at a substantially larger distance e.g. at different platforms, e.g. each at a different wing then the lasers may vibrate out of phase, and as a result cause large inaccuracies in the distance where the beams intersect. The preferred arrangement of the present invention, wherein the light beam sources are arranged in each other's vicinity therefore has the advantages of an increased structural stability of the lasers with respect to each other, in particular if the lasers are arranged at the same platform. Despite the shallower intersection in the embodiment with a system having the lasers of a light-emitting device arranged in the neighbourhood of each other, the distance to the plane where the beams intersect can be set more accurate.

An additional advantage of said preferred arrangement is that the path length of the beams projected from these sources is substantially equal, so that in circumstances of dust or fog the beams have a substantially equal attenuation of their intensity. Furthermore, given a predetermined distance of the intersection to the plane, the total path length can be relatively small, so that the observed light intensity at the point of intersection is relatively high.

Surprisingly, in the arrangement of the invention, with lasers as light sources, the presence of dust or fogs aids the pilot in navigation as it causes the laser beams themselves and their point of intersection to become visible.

In particular the arrangement of the invention complemented with a night vision system, in particular night vision goggles to be worn by the pilot, provides the best results.

Expected benefits are that the system supports the pilot to land while sight of the surface is obscured.

Secondly the NVG pilot will gain time to react to the onset of visual obscurants. Just a little bit of extra time will help to either 1) land safely or 2) abort the landing safely.

Thirdly it is reasonable to expect that the extra visual information will provide extra security making it possible to land more quickly, causing in turn less dust to be kicked up in front of the helicopter.

Fourthly the laser beams may make the onset of heavy obscurants less surprising.

The physical principle will be outlined next.

Night-light coming from above (moon, stars, scatter) illuminates the ground surface as well as the atmospheric obscurant. The latter adds a veil of light, decreasing the contrast of the NVG image. This effect is comparable with the use of net curtains: the dark parts of a scene become invisible first and the bright parts stand out best. This is the reason why one can look through a net curtain from inside to outside, but not from outside in. In the same way, the laser beams are by far the brightest parts of the NVG scene and therefore remain visible in the atmospheric obscurant. The principle still applies during the day, but would require powerful lasers which are not eye-safe.

Contrary to the pattern of isolated dots provided by the system known from USP 5,315,296, the pattern of intersecting beams according to the invention gives a much more intuitive spatial orientation and explicitly shows distance. In particular the visibility of the mutually intersecting beams in the system according to the invention is important when an atmospheric obscurant is present. Additionally the concept according to the present invention provides information regarding the air vehicle roll and/or pitch with respect to the surface. Other differences are

1. the purpose (travel versus landing),
2. the exact configuration of the lights, and
3. the specific purpose for use in brown-out / white-out.

Brief description of the drawings

These and other aspects of the present invention are described in more detail with reference to the drawing. Therein:

Figure 1 shows schematically a preferred embodiment of an aircraft vehicle according to the invention.

Detailed description of the invention

Figure 1 shows an aircraft vehicle, a helicopter 1, comprising a number of light emitting devices 2 and 3 respectively, which are arranged to emit a converging light beam 4 - or a set of converging light beams – which have their intersection 5 at a predetermined level 6 below the aircraft vehicle 1.

Each of said light emitting devices may comprise at least two light beam sources. It is preferred, however, for sake of reliability when each of said light emitting devices comprising (at least) three light beam sources. Each light beam source may be formed by a laser. The characteristics of those lasers will further be discussed below.

As visible in figure 1, two of said converging light emitting devices 2, are mounted on either side of the aircraft vehicle. By mounting – in this preferred embodiment - two light emitting devices 2 side-by-side, the helicopter's "roll" becomes visible as the asymmetry between the light beams coming from the two sets. Drift is the result of a helicopter roll; the two-set configuration therefore also provides (indirect) information about drift during landing.

Similarly the helicopter's pitch may be made visible by adding – in a further preferred embodiment - a third light emitting device 3, mounted in front (or behind) the imaginary connection line between said two light emitting devices 2 on either side of the vehicle.

It is preferred, as figure 1 shows, that the light emitting devices 2 and 3 are arranged so that the converging light beams or sets of converging light beams have their intersection at the predetermined level below the aircraft vehicle within an area 7 in front of the vehicle, within the field of vision of the vehicle's crew, especially its pilot. More in particular the light beam sources of each of the light emitting devices 2, 3 are arranged in each other's vicinity. Each light-emitting device comprises two or three lasers that are mounted at a distance of at most 30 cm from each other.

It is noted that figure 1 shows the situation that the beam intersection falls exactly at the ground surface. When the aircraft vehicle is flying higher, the beam intersections will be above the surface and the beams will be seen diverging below the intersection. When the aircraft vehicle is flying lower, the beam intersections will not be visible, each beam ends as a bright dot where it hits the surface. When the aircraft vehicle is flying level the converging beams will be symmetrical. When the aircraft vehicle is not flying level the converging beams will be asymmetrical. On the side of the air vehicle that is rolled up and/or pitched up, the beam convergence point is farther above the ground at high altitudes and the closer to the ground at low altitudes. The pilot's ability to judge the height, roll, and pitch of the aircraft vehicle will be more accurate as the point of intersection is closer to the surface, but will still be sufficiently accurate to be of help well above and below this point.

Referring to the characteristics of the lasers etc.:

1) a limited number of e.g. battery powered red or near-IR lasers;

2) mounted either directly to the helicopter or to a structure (“emergency triangle”) which in turn is mounted to the helicopter, and

3) an on/off switch within reach of a crew-member.

The required power is low to medium because the NVG amplifies the light approximately 10000 times. The low power lasers are eye-safe. Basically, per light emitting device two lasers are sufficient to create the intersection. However, the preferred addition of a third laser per light emitting device makes any alignment error immediately visible to the helicopter crew because it will cause two intersections. This virtually eliminates maintenance check-ups.

Resuming, when the crew of a heli, wearing NVG’s cannot see through e.g. dust, snow etc. laser sources, as outlined above, can still penetrate it. The lasers may have their intersection point at say 5 meters below and in front of the helicopter. When during the landing dust kicks in, the laser lines will appear. As long as the distance to the ground is larger than the 5 meters, the intersection is visible. When he distance is shorter the laser lines no longer intersect. When the dust becomes too thick the lines gradually disappear without ending in a bright spot. If the ground is perfectly level the three dots gradually converge and then diverge. If the ground is bumpy the three dots jump around and the time average (low-pass) position converges then diverges. If the system is misaligned the three lasers no longer intersect at one location. If two sets of lasers are placed side by side (left & right) an asymmetry means that the helicopter is not in level with respect to the ground. Three sets of lasers also provide the pitch. Simulations of converged lasers in a smoke filled room learn that the visual patterns caused by the configuration of light emitting devices (2,3) appear reasonably intuitive. This makes sense from a perception point of view: symmetry is a Gestalt etc.

Claims

1. Aircraft vehicle (1), comprising light emitting devices (2,3) each of them being arranged to emit a converging light beam (4) or a set of converging light beams which intersect (5) at a predetermined level (6) below the aircraft vehicle, comprising two of said light emitting devices (2) being mounted on either side of the aircraft vehicle (1) and comprising a third light emitting device (3), mounted in front or behind the imaginary connection line between said two light emitting devices (2) on either side of the vehicle.

2. Aircraft vehicle according to claim 1, each of said light emitting devices comprising at least two light beam sources.

3. Aircraft vehicle according to claim 2, each of said light emitting devices comprising three light beam sources.

4. Aircraft vehicle according to claim 2 or 3, wherein the light beam sources of a light emitting device are arranged in each others vicinity.

5. Aircraft vehicle according to any of claims 2, 3, or 4 wherein said light sources are lasers.

6. Aircraft vehicle according to claim 1, said light emitting devices being arranged to emit said converging light beam or said set of converging light beams which intersect at a predetermined level below the aircraft vehicle within an area (7) in front of the vehicle which visible for the vehicle's crew.

7. Aircraft vehicle according to claim 5, further comprising a night vision system adapted to a wavelength range of the lasers.

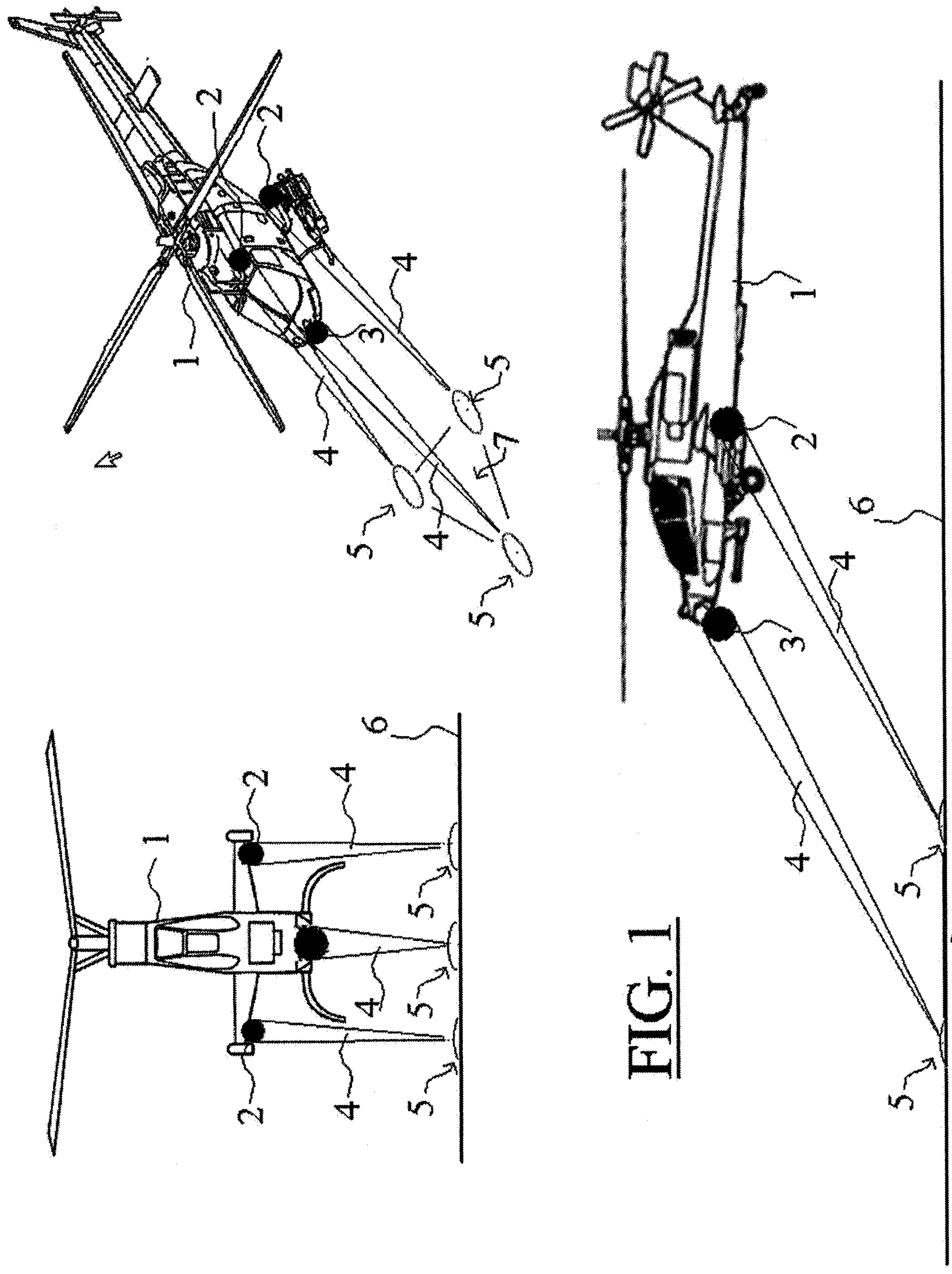

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2007/050231

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64D47/04

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)
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 practical, search terms used)

EPO-Internal

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 2 532 104 A (KING JAMES THOMAS) 28 November 1950 (1950-11-28) column 2, line 38 - column 5, line 32; figures	1-4,6 5,7
Y	US 5 315 296 A (KAISER ET AL) 24 May 1994 (1994-05-24) cited in the application column 3, line 29 - column 5, line 22; figures	5,7
A	US 2 017 692 A (GATY JOHN P) 15 October 1935 (1935-10-15) column 2, line 53 - column 4, line 11; figures	1-7

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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 :

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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
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	SILVA D'OLIVEIRA NAV

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 510 495 A (MARIO COCCON; PIETRO TORTA) 2 August 1939 (1939-08-02) page 1, line 62 - page 2, line 35; figures	1-7
A	US 6 028 624 A (WATKINS ET AL) 22 February 2000 (2000-02-22) column 2, line 49 - column 3, line 42; figure 1	1-7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NL2007/050231

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 2532104	A	28-11-1950	NONE	
US 5315296	A	24-05-1994	NONE	
US 2017692	A	15-10-1935	NONE	
GB 510495	A	02-08-1939	NONE	
US 6028624	A	22-02-2000	NONE	