(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 April 2014 (10.04.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/055044 Al

(51) International Patent Classification: *BMC 31/036* (2006.01)

(21) International Application Number: PCT/SK20 13/0000 11

(22) International Filing Date: 26 September 2013 (26.09.201 3)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
76/2012 1 October 2012 (01. 10.2012) SK

(72) Inventor; and
(71) Applicant : SVEC, Miroslav [SK/SK]; Ing. Miroslav SVEC, Snezienkova 6, 94501 Komarno (SK).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

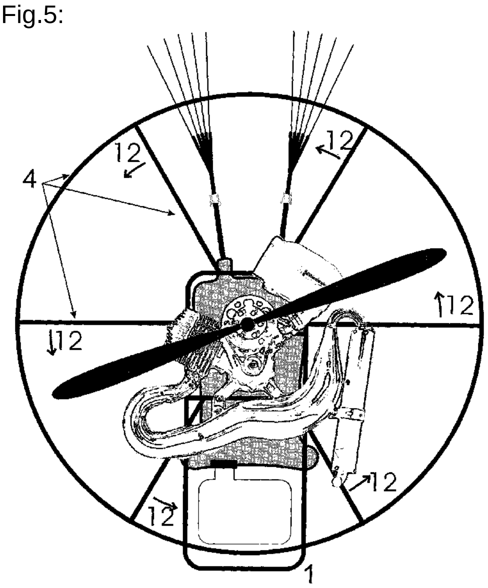
— *as to the identity of the inventor (Rule 4.1 7(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.1 7(ii))*

[Continued on next page]

(54) Title: PARAMOTOR WITH DYNAMIC TORQUE COMPENSATION

Fig.5:



(57) Abstract: Paramotor with dynamic torque compensation comprises of frame (1), harness or seat (2), engine and propeller (3) rotating in a cage (4) characterized by one or more surfaces placed on said frame and/or said cage in such a way that when air flows around them aerodynamic forces are generated in th eopposite direction to the propeller torque. These surfaces are characterized by asymetric profile (13), symetric profile with non-zero angle of attack (14), asymmetric profile with non-zero angle of attack (15) or in a form o flaps or ailerons with non-zero angle of attack (16). Said surfaces may have adjustable angle of attack (17).

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

— *as to non-prejudicial disclosures or exceptions to lack of novelty (Rule 4.17(v))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Description

Paramotor with dynamic torque compensation

Technical Field

[I] The invention relates to aviation, specifically to powered paragliding with paramotors as the power unit. Powered paragliding uses air-inflated wings to generate lift and paramotors to generate forward thrust. The paramotor is commonly a combustion or electric engine which drives a propeller. The paramotor is usually foot-launched (carried on the pilots back as a backpack) or constructed as a lightweight trike with wheels or ski.

Background Art

[2] No matter what motor (combustion or electric) is used for creating the power, when the power is transmitted to the propeller it causes two effects:

[3] 1. thrust

[4] 2. torque.

[5] THRUST is the power that pushes the paramotor forward and enables the powered paraglider to fly and even climb.

[6] TORQUE involves Newton's Third Law of Physics - which states that for every action there is an equal and opposite reaction. If the propeller turns counter-clockwise (5) as seen from behind the propeller, torque effect causes turning of the whole paramotor clockwise (6). Rotation of the paramotor causes higher load (9) of the right paraglider risers (7) and less load on the left side (8). As a result the powered paraglider turns right instead of flying straight.

[7] No matter how efficient the propeller is, there will always be noticeable torque effect. The more powerful the paramotor is and the faster the propeller turns, the higher the torque effect will be.

[8] Torque effect grows exponentially with the rotation speed of the propeller.

[9] As the powered paraglider has the tendency to turn to the right, it is more difficult to steer it precisely. The powered paraglider turns much better to the right than to the left.

[10] The further text of patent description refers to paramotors with counter-clockwise turning propeller and torque effect causing right turn of the powered paraglider.

[II] The text applies the opposite way for paramotor with clockwise turning propeller. The principle of innovation is valid no matter what direction the propeller turns.

Disclosure of Invention

Technical Problem

[12] Presently known paramotors use weight-shift for compensating the torque effect. There are three methods of weight-shift compensation widely used:

[13] 1. Moving the center of gravity of the paramotor to the left. Moving the center of gravity can be done by asymmetric placement of the engine, where the engine as the

heaviest part of paramotor is placed to the left as seen from behind, thus creating the counter-clockwise momentum.

[14] 2. The other commonly used weight-shift method is offsetting of the carabiners to the right. The left riser is therefore closer to the center of gravity of the paramotor and is loaded more, than the right riser.

[15] More weight load on the left riser compensates the torque effect loading the right riser.

[16] 3. Some paramotors use an adjustable anti-torque strap. It is a diagonal strap that connects the bottom right end (around the right knee) of the seat with the left risers. This strap is adjustable and shortening of the strap transfers some part of the right leg's weight to the left riser. This causes more load of the left riser as a compensation of the torque effect.

[17] Some paramotors combine two or all above mentioned methods to achieve sufficient torque compensation.

[18] All three above mentioned methods of torque compensation have one common characteristics: the compensation is fixed. The weight shift is predefined by the construction of the paramotor and harness (or by the set length of the anti-torque strap). While the torque effect grows with the power of the paramotor (more throttle = more torque effect) the weight shift compensation stays the same.

[19] A well-engineered paramotor is balanced for level flight, i.e. mid-range engine and propeller revolutions necessary for maintaining constant level flight. If the pilots adds more power in a curve or for climbing, the torque effect grows exponentially but weight/shift compensation stays the same. The powered paraglider will turn to the right. If the pilots reduces power to idle revolutions, the torque effect will be dramatically reduced. The weight shift compensation becomes useless but is still present and the paraglider will start to turn to the left.

[20] Same happens if the pilot uses for example a smaller wing or changes the wing profile (trimmers out for some wings with adjustable geometry). Smaller wings or wings trimmed out fly faster and need more power to maintain level flight. Such pilot will experience right turning tendency even with well designed paramotor, because he flies the paramotor at more power than the designer has expected or used as average.

[21] **Currently used torque compensation systems are therefore static, fixed by the design at some engine and propeller revolutions. If the motor is running at lower or higher revolutions, the torque compensation is not equal to torque and the powered paraglider is unable to fly straight without pilot's steering input. Further, its easier to turn the powered paraglider in the direction of torque and more difficult in the direction opposite to propeller torque.**

[22] All above described methods of torque compensation apply also to paramotors with clockwise-turning propeller respectively.

Technical Solution

[23] The fast turning propeller is for security reasons protected by a round cage. There are many various designs of cage, basically consisting of the main ring and arms. Presently produced paramotors have cages made mostly from tubes (aluminium or steel). A few of them use some sort of symmetric aerodynamic profile to reduce drag of the cage.

[24] Paramotor with dynamic torque compensation uses the air flowing through the cage (4) to generate rotational lift (12) that compensates the torque effect. This can be achieved by using properly designed surfaces on the cage and proper choice of arms direction.

[25] Surfaces made of asymmetric airfoil profile (13), symmetric profiles (14) having non-zero angle of attack (17) will generate lift when air is flowing around it.

[26] Lift-generating surfaces placed to radial position or substantially radial position from the center of propeller rotation to the ring and shaped to generate lift in the same direction will together create rotational momentum opposite to the torque effect. Perfectly radial position of the lift-generating surfaces will generate best results.

[27] The more lift-generating surfaces with asymmetric profile and/or non-zero angle of attack are used, the stronger the rotational momentum is.

[28] The faster the propeller turns, the more torque it creates. At the same time a faster turning propeller will create higher speed of air flowing through the cage and thus increasing the rotational lift force of the lift-generating surfaces.

[29] The torque compensation is lower at low propeller rpm and higher at higher propeller's rpm.

[30] My research showed, that it is possible to design the airfoil-shaped arms in the way that the rotational lift generated by the arms grows the same way as the torque effect when the propeller turns faster. As a result, compensation of the torque is equal or very close to the torque at any propeller turning speed.

[31] The invented paramotor torque compensation is thus dynamic.

Advantageous Effects

[32] Paramotor with dynamic torque compensation is capable to fly straight or with minimal turning tendency without pilot input at any speed of flight, i.e at any paraglider's trim setting, with speed bar or without.

[33] Paramotor with dynamic torque compensation is capable to fly straight or with minimal turning tendency without pilot input at both horizontal flight or ascending at full power.

[34] Paramotor with dynamic torque compensation is capable of making sharp turns using full power equally to both sides without and its turning capability is not affected by propeller torque.

Description of Drawings

[35] Drawing No. 1 displays a paramotor comprising of frame, harness, engine and propeller rotating in a cage. The cage comprises of ring and arms.

[36] Drawing No.2 displays the torque effect causing rotation (6) of the paramotor and thus increased load (9) of one of the risers (7,8).

[37] Drawing No.3 displays radially (18) positioned surfaces that generate rotational lift (12) when air flows around them.

[38] Drawing No. 4 displays different surfaces that generate lift when air flows around them

Industrial Applicability

[39] Individual examples are for illustration only and practical implementation of the invention is not limited to these examples.

[40] Example 1: Paramotor comprising of frame (1), harness or seat (2), engine and propeller (3)rotating in a cage (4). The arms of the cage are made of profiles incorporating lift-generating surfaces. Arms are in (close to) radial position, thus their combined lift force generates rotational momentum to compensate propeller torque.

[41] Example 2: Paramotor with one or more shapes (such as flaps or ailerons used on airplanes with non-zero angle of attack and/or asymmetric profile) attached to a regular cage. Such a construction will have the same dynamic torque compensation effect although with probably higher drag.

[42] Example 3: Paramotor with lift-generating surfaces such as flaps and ailerons attached to the cage with adjustable angle of attack. The angle of attack can be adjusted either during flight or before take-off.

[43] Example 4: Paramotor with lift-generating surfaces such as flaps and ailerons attached to the cage with adjustable angle of attack. The flaps are connected to the throttle wire, thus the angle of attack is automatically adjusted with throttle lever movement. The pilot by pushing the throttle control simultaneously increases engine power and increases the angle of attack of the flaps.

Claims

[1] Paramotor with dynamic torque compensation comprising:
a frame (1), a harness or seat (2), a power unit, a propeller (3) which rotates and a cage (4),
characterized by:
one or more surfaces (13,14,15,16) on said frame or said cage positioned such that when air flows over them a compensating torque is generated in an opposite direction to that of the propeller torque effect (6).

[2] Paramotor according to claim 1 characterized by said one or more surfaces (13,14,15,16) being positioned radially (18) or substantially radially relative to the axis of rotation of said propeller.

[3] Paramotor according to claims 1 or 2 characterized by said one or more surfaces (13,14,15,16) being adapted to generate lift which in turn generates said compensating torque

[4] Paramotor according to any of the preceding claims characterized by said one or more surfaces having asymmetric profile (13), symmetric profile with non-zero angle of attack (14), an asymmetric profile with a non-zero angle of attack (15) or a form of flaps or ailerons with non-zero angle of attack (16).

[5] Paramotor according to any of the preceding claims characterized by said surfaces being integrated into said paramotor cage or said frame such that some parts of said cage or said frame are formed from asymmetric profile (13), symmetric profile with non-zero angle of attack (14), or asymmetric profile with non-zero angle of attack (15).

[6] Paramotor according to claims 1 to 4 characterized by said surfaces (13,14,15,16) being attached to said paramotor cage or frame .

[7] Paramotor according to any of the preceding claims characterized by said surfaces having an adjustable angle of attack (17).

[8] Paramotor according to any of the preceding claims characterized by said paramotor either being adapted for foot-launch or being mounted on a frame with wheels, skis or pontoons.

Method claims

[9] Method of dynamic torque compensation for a paramotor comprising:
a frame, a harness, a power unit, a propeller which rotates and a cage,
said method characterized by the steps of:
allowing air to flow over said one or more surfaces (13,14,15,16) on said frame or said cage, said surfaces being positioned such that
a compensating torque is generated in an opposite direction to that of the propeller torque effect (6).

[10] Method according to claim 9 characterized by said one or more surfaces (13,14,15,16) being positioned radially (18) or substantially radially relative to

the axis of rotation of said propeller.

[11] Method according to claims 9 or 10 characterized by said one or more surfaces (13,14,15,16) being adapted to generate lift which in turn generates said compensating torque.

[12] Method according to any of claims 9 to 11 characterized by said one or more surfaces having an asymmetric profile (13), a symmetric profile with non-zero angle of attack (14), an asymmetric profile with a non-zero angle of attack (15) or a form of flaps or ailerons with non-zero angle of attack (16).

[13] Method according to any of claims 9 to 12 characterized by said surfaces being integrated into said paramotor cage or said frame such that some parts of said cage or said frame are formed from asymmetric profile (13), symmetric profile with non-zero angle of attack (14), or asymmetric profile with non-zero angle of attack (15).

[14] Method according to any of claims 9 to 12 characterized by said surfaces (13,14,15,16) being attached to said paramotor cage or frame.

[15] Method according to any of claims 9 to 14 characterized by said surfaces having an adjustable angle of attack (17).

[16] Method according to any of claims 9 to 15 characterized by said paramotor either being adapted for foot-launch or being mounted on a frame with wheels, skis or pontoons.

Fig.1

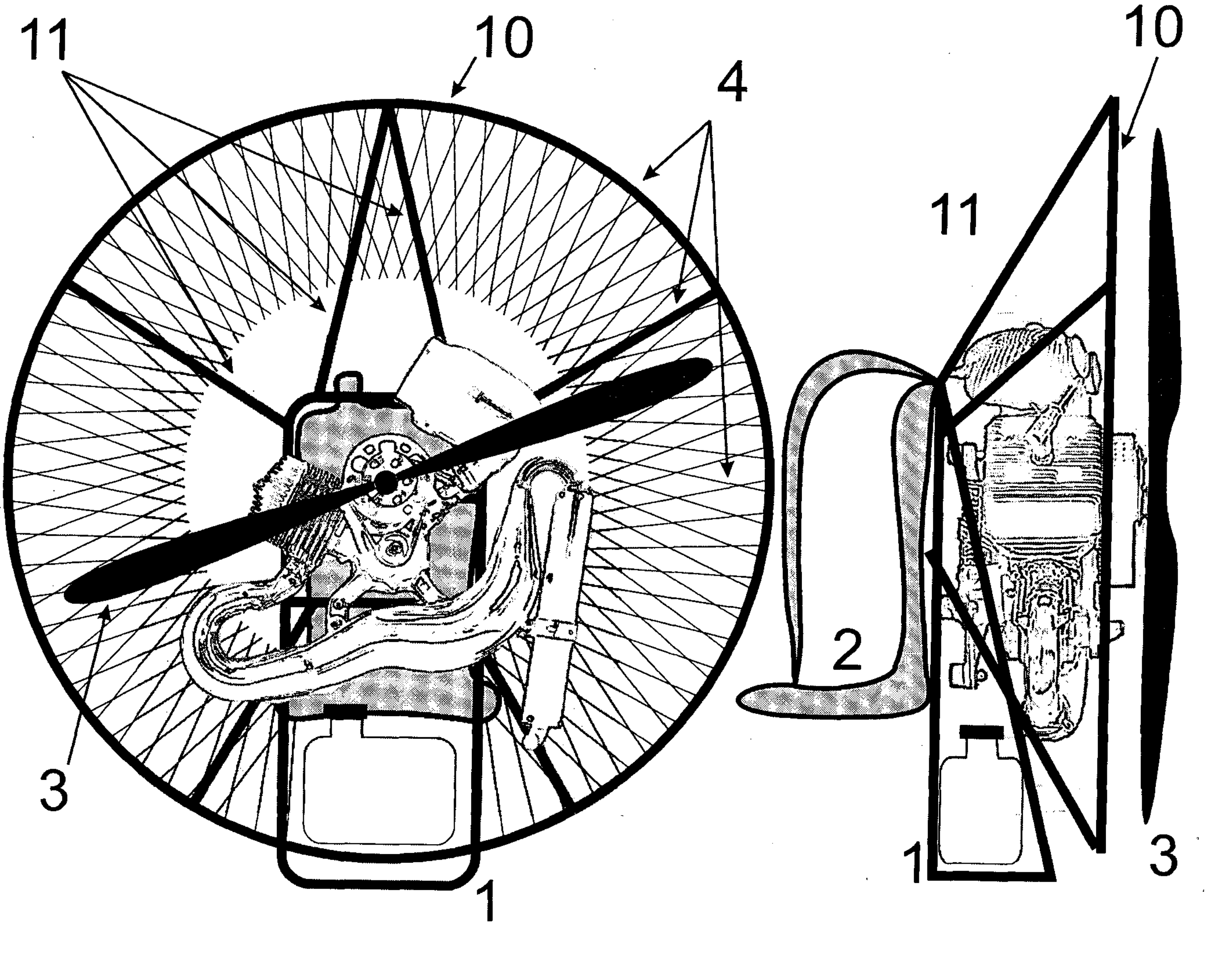


Fig.2

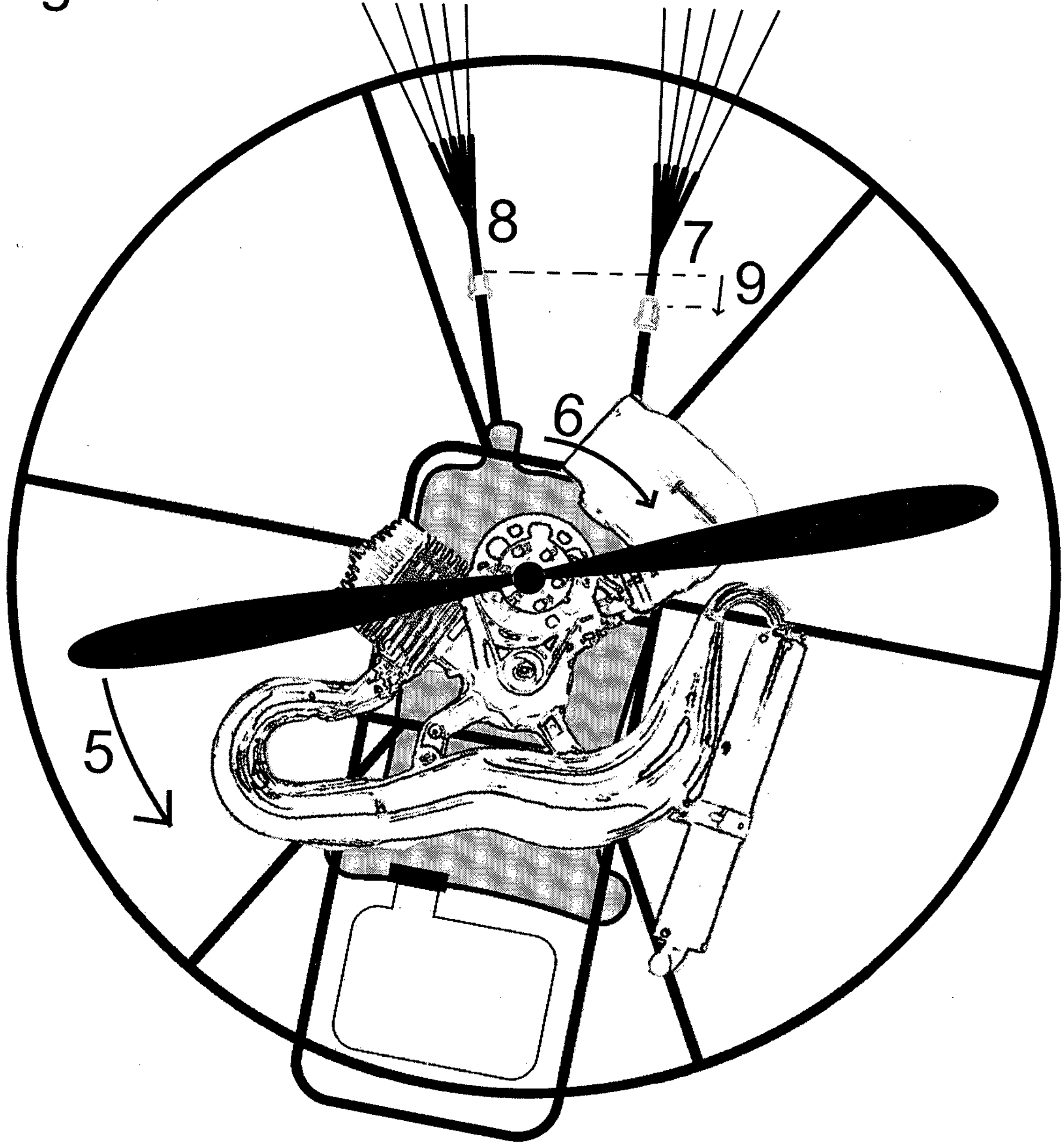


Fig.3

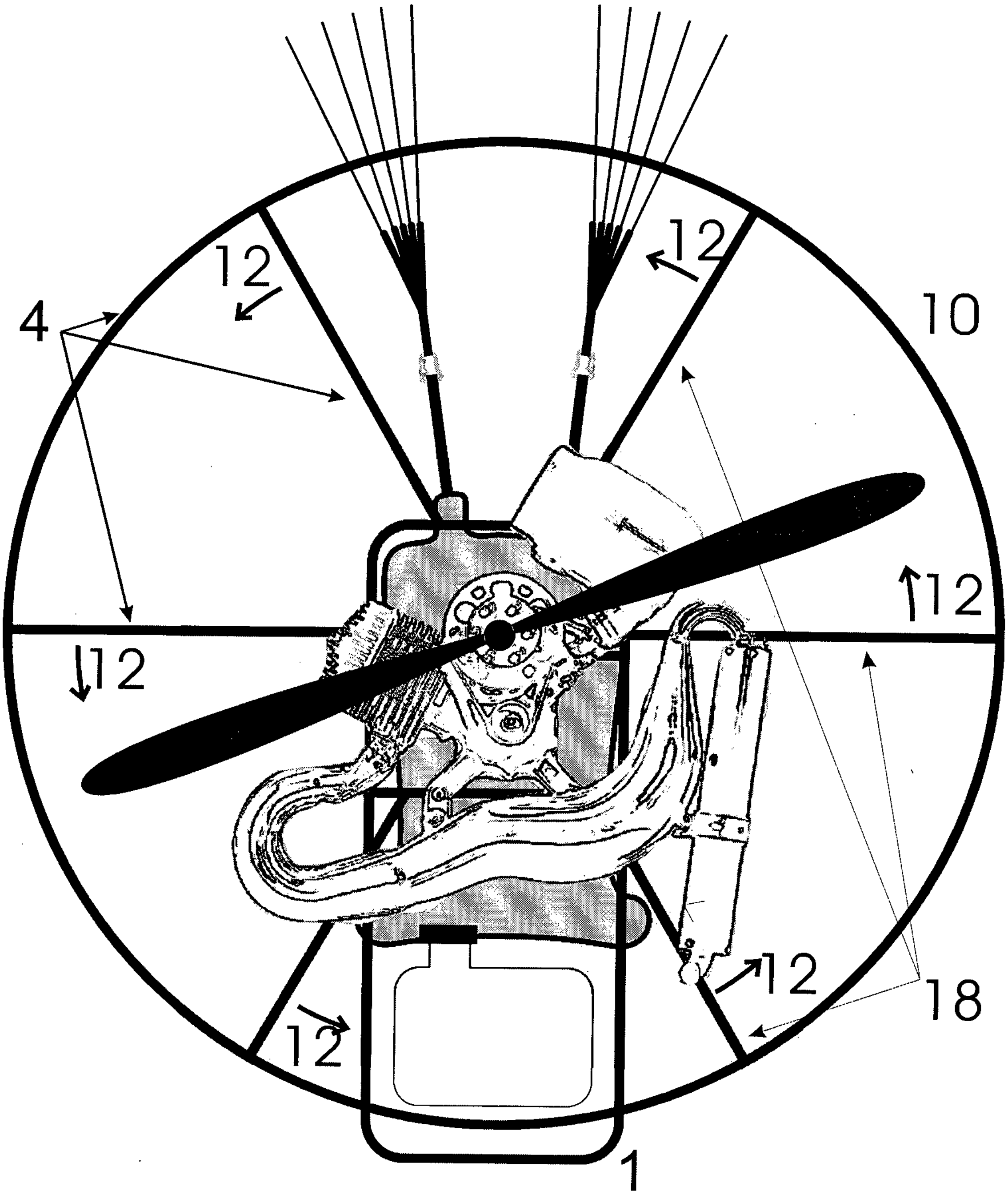


Fig.4

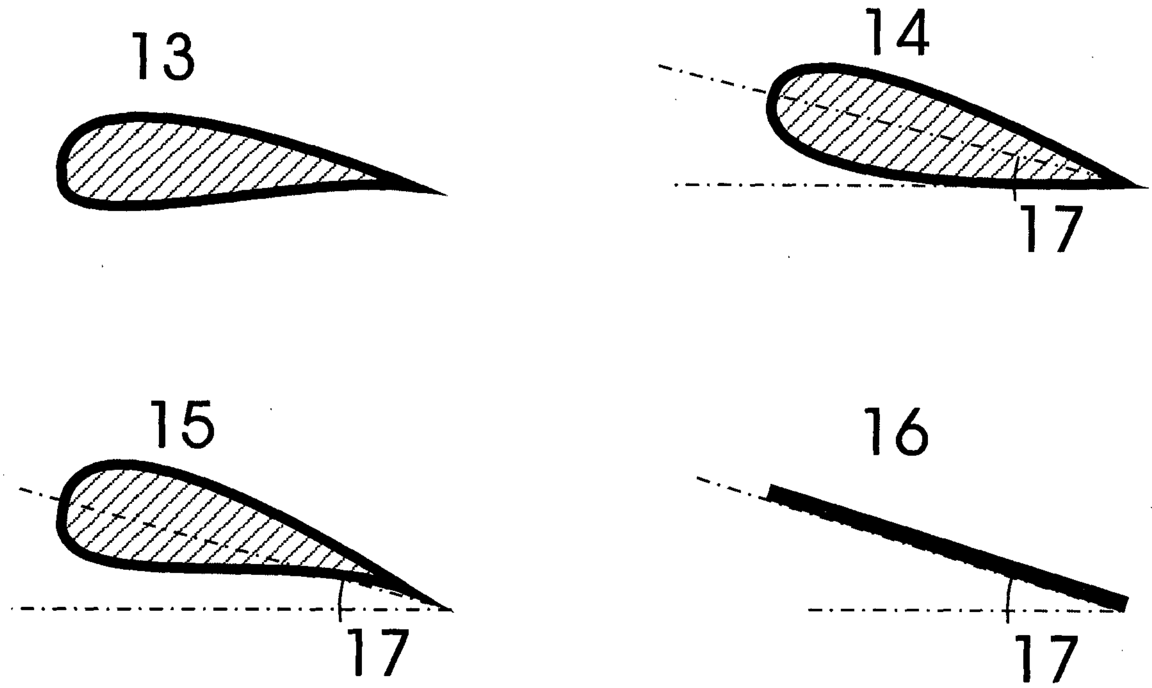
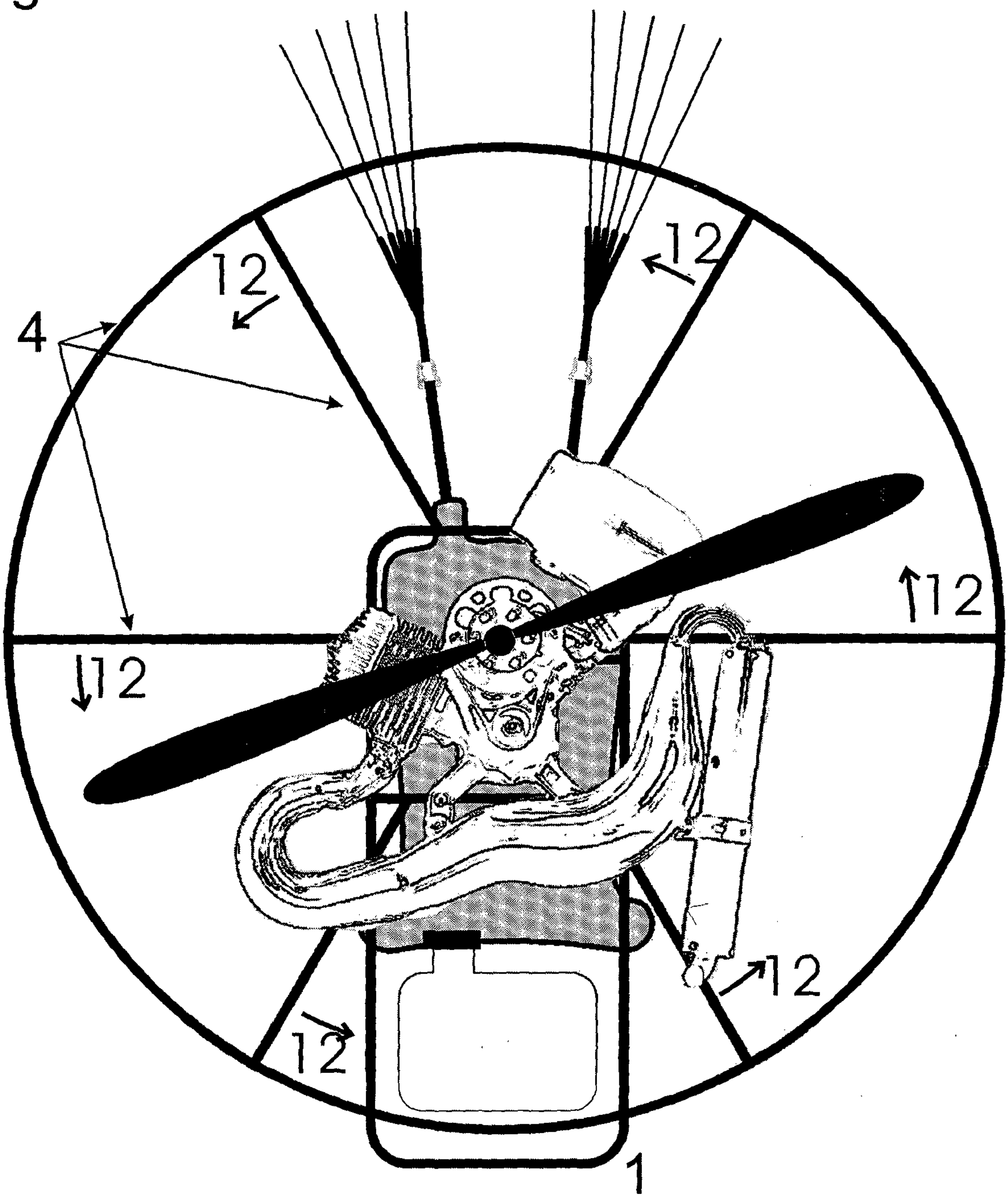


Fig.5:



INTERNATIONAL SEARCH REPORT

International application No
PCT/SK2013/000011

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C31/036
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.
X	US 5 620 153 A (GINSBERG HAROLD M [US]) 15 April 1997 (1997-04-15) figures 1,3A-3F,6 column 3, lines 36-60 column 9, lines 6-15 column 9, line 49 - column 10, line 9 -----	1-4, 6-12, 14-16
X	FR 2 679 867 Al (BLOTTIN GEORGES [FR]) 5 February 1993 (1993-02-05) page 2, lines 4-10 claim 4; figure 8 -----	1-4,6, 8-12, 14, 16
X	US 4 934 630 A (SNYDER STEPHEN L [US]) 19 June 1990 (1990-06-19) column 11, lines 46-66; figure 1 -----	1,3,4,6, 8,9,11, 12,14, 16

-/--

[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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 January 2014	11/02/2014

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	Cesaro, Ennio

INTERNATIONAL SEARCH REPORT

International application No
PCT/SK2013/000011

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 278 784 A2 (POWERCHUTE SYSTEMS INTERNATION [GB]) 17 August 1988 (1988-08-17) abstract; figure 1 -----	1,9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/SK2013/000011

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5620153	A	15-04-1997	NONE			
FR 2679867	A1	05-02-1993	NONE			
US 4934630	A	19-06-1990	NONE			
EP 0278784	A2	17-08-1988	AU	1171888	A	18-08-1988
			EP	0278784	A2	17-08-1988
			US	4875642	A	24-10-1989