(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 812 251 B9**

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see
Description Paragraph(s) 25

(48) Corrigendum issued on:
09.05.2012 Bulletin 2012/19

(45) Date of publication and mention of the grant of the patent:
07.12.2011 Bulletin 2011/49

(21) Application number: **05798065.8**

(22) Date of filing: **11.10.2005**

(51) Int Cl.:
B60F 5/02 *(2006.01)* ***B64C 37/00*** *(2006.01)*
B62K 13/00 *(2006.01)* ***B64C 27/02*** *(2006.01)*

(86) International application number:
PCT/NL2005/000735

(87) International publication number:
WO 2006/041287 (20.04.2006 Gazette 2006/16)

(54) PERSONAL LAND AND AIR VEHICLE

PERSONENLAND- UND -LUFTFAHRZEUG

VEHICULE PERSONNEL TERRESTRE ET AERIEN

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(30) Priority: **12.10.2004 NL 1027222**

(43) Date of publication of application:
01.08.2007 Bulletin 2007/31

(73) Proprietor: **PAL-V Europe NV**
5109 RE 's Gravenmoer (NL)

(72) Inventor: **Bakker, Jan Willem Dan**
5109 Re's Gravenmoer (NL)

(74) Representative: **Griebling, Onno**
Octrooibureau Griebling BV,
Sportweg 10
5037 AC Tilburg (NL)

(56) References cited:
DE-A1- 4 119 810
DE-A1- 10 159 082
US-A- 2 110 563
US-A- 3 771 923
US-A- 5 203 520
US-A- 5 915 649
US-A- 5 927 424

- **"GYROCOPTER DUTCH SEEK FUNDS TO SPARK FLYING MOTORCYCLE" FLIGHT INTERNATIONAL, REED BUSINESS INFORMATION, SUTTON SURREY, GB, vol. 166, no. 4959, 9 November 2004 (2004-11-09), page 26, XP001209536 ISSN: 0015-3710**

EP 1 812 251 B9

Description

FIELD OF THE INVENTION

[0001] The present invention relates in general to a vehicle capable of riding on land and flying in air.

BACKGROUND OF THE INVENTION

[0002] A vehicle of the above type is described in German Offenlegungsschrift 101.59.082. An important disadvantage of this known vehicle is the fact that has fixed wings which must be attached before flying, and must be detached after flying in order to be capable of road traffic. The same applies to the propeller. The wings and the propeller must be left at the airport, and the vehicle must return to this airport for the next flight. This makes the transition from land-vehicle to air-vehicle and back a complicated operation, which is not attractive to the user.

[0003] A vehicle according to the preamble of independent claims 1 and 4 is disclosed in US-3.771.923. In this known vehicle, the rotor base has a fixed position with respect to the vehicle, and the rotor blades have a hinge at approximately one-third of their length dividing the blades in an inner section and an out section. The inner blade section is fixedly mounted to the rotor base, and the outer blade section is hingedly mounted to the inner blade section. The two blades always extend at 180° with respect to each other. In the riding position, one blade has its inner blade section extending to the rear and has its outer blade section extending from the hinge forwards, while the other blade has its inner blade section extending forwards and has its outer blade section extending from the hinge to the rear.

[0004] An important objective of the present invention is to provide a vehicle of the above type which has an improved usefulness, especially less complicated transition from land-vehicle to air-vehicle and back. Specifically, the present invention aims to provide a vehicle which is actually suitable for comfortable road traffic with a suitable speed, and which can easily be converted into an air-vehicle, for take-off and landing at virtually any location.

SUMMARY OF THE INVENTION

[0005] According to an important aspect of the present invention, a vehicle comprises a rotor with foldable rotor blades, although detachable rotor blades are envisaged as an alternative. The rotor is mounted on a rotor support which is capable of a displacement in the longitudinal direction of the vehicle. In flying mode, the rotor blades are extended, and the centre of the rotor is located substantially above the mass centre of the vehicle. In riding mode, the rotor blades are folded such that they extend substantially parallel to the longitudinal direction of the vehicle, while the centre of the rotor is displaced towards the front end or rear end of the vehicle.

[0006] According to another important aspect of the present invention, the rotor blades are extendable like a telescope, as expressed in claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] These and other aspects, features and advantages of the present invention will be further explained by the following description with reference to the drawings, in which same reference numerals indicate same or similar parts, and in which:

figure 1 schematically shows a side view of a personal land and air vehicle in accordance with the present invention;
figures 2A-B are schematic rear views of the vehicle, illustrating the behaviour of the rear wheels in a curve;
figures 3A-C are schematic rear and top views of the vehicle, illustrating the extendable tail;
figures 4A-B are schematic rear views of the vehicle, illustrating the extendable blades of the propeller;
figures 5A, 5B and 5C are schematic side, rear and top views, respectively, of the vehicle, illustrating the rotor in flight condition;
figures 6A-B are schematic side and top views of the vehicle, illustrating the rotor in riding condition;
figures 6C-D are schematic top views of part of the vehicle, illustrating extendable rotor blades;
figure 7 is a schematic top view of the vehicle, illustrating an alternative embodiment of extendable rotor blades; figure 8 illustrates a preferred detail of the extendable rotor blades.

DETAILED DESCRIPTION OF THE INVENTION

[0008] Figure 1 schematically shows a side view of a vehicle 1 in accordance with the present invention. The vehicle 1 comprises a cabin 2, front wheel 3, and two rear wheels 4L and 4R, only one rear wheel 4L being visible in figure 1. The rear wheels 4 are driven by a motor (not shown), which may be any suitable conventional motor. The cabin 2 accommodates a seat for a driver, steering wheel or the like, control equipment, etcetera, all of which is not shown for sake of simplicity. Although not essential, it is preferred that the vehicle 1 has one front wheel 3, located at the longitudinal centre line of the vehicle. Alternatively, the vehicle 1 may for instance have two front wheels located close together. As a result, the frontal width of the vehicle is relatively small, which contributes to an advantageous air resistance coefficient.

[0009] For flying purposes, the air resistance coefficient should be as low as possible, therefore the vehicle should have an aerodynamic profile with a small width. In the preferred embodiment, the vehicle has a width for accommodating one person. In order to enhance the transverse stability in riding mode, the cabin 2 is tiltable around a longitudinal axis. The front wheel 3 tilts along

with the cabin.

[0010] In said German Offenlegungsschrift 101.59.082 to BMW, it is mentioned that the vehicle is tiltable, but the publication does not mention what kind of tilting system is to be used. Tilting systems for vehicles as such are known, wherein the tilting angle is usually based on the steering angle (the angle of the steering wheel with respect to the neutral position). In accordance with a preferred embodiment of the present invention, an active tilting system is used, wherein the tilting angle of the vehicle is controlled in relationship to forces acting on the front wheel. Thus, when riding in a curve, the tilting angle can depend on the speed. On the other hand, when riding in slippery conditions, in the case of full steering angle, the tilting angle may be small or even remain zero. Such active tilting system is known per se; by way of example, reference is made to US patent 5.927.424 to Brinks Westmaas BV. Therefore, a more detailed description of such active steering system is not necessary here.

[0011] In the active tilting system of said US patent 5.927.424, the vehicle comprises a tilting cabin unit and a stationary unit which comprises a frame, the drive motor and the rear wheels; the cabin unit tilts with respect to the stationary unit. In the vehicle of the present invention, there is no such stationary unit: the motor is fixed with respect to the cabin, and tilts along with the cabin. Also the rear wheels 4 tilt along with the cabin 2, with the understanding that, although the attitude of the rear wheels 4 tilts, the mutual positional relationship of the rear wheels with respect to the road remains the same. More particularly, the centre points of the rear wheels 4 remain substantially in a horizontal plane (assuming a horizontal road). This is illustrated in figures 2A and 2B, which are schematic rear views of the vehicle 1 in a condition for straight travel (not tilted, figure 2A) and a condition for taking a curve (tilted, figure 2B). To this end, the wheels are mounted to the cabin such as to be oppositely displaceable in the vertical direction with respect to the cabin: if one wheel is lifted, the other wheel is lowered over the same distance, and vice versa. The vehicle comprises a mechanism for actively setting the vertical position of the rear wheels with respect to the cabin. This mechanism comprises a power sensor measuring the load of the front wheel, and a wheel position actuator controlled by the output signal of said power sensor. In a preferred embodiment as illustrated, the wheels 4 are mounted on respective arms 5, each arm 5L, 5R substantially extending in the longitudinal direction of the vehicle, parallel to the side of the cabin 2, carrying the corresponding wheel 4L, 4R at a rear arm end, while the front end 6L, 6R of the arm 5L, 5R is mounted to pivot around a horizontal transverse axis. In the condition for straight travel (not tilted, figure 2A), the arms 5L, 5R are at the same level. When the said power sensor senses a force corresponding to a left-hand turn (figure 2B), the said actuator rotates the left-hand arm 5L upwards thus lifting the left-hand wheel 4L, while simultaneously the right-hand arm 5R is rotated downwards thus lowering the right-hand wheel 4R; as a consequence, the cabin 2 is tilted. It can be seen in figure 2B that the wheels 4L, 4R remain substantially parallel to the sides of the tilted cabin 2.

[0012] It should be clear that, for a right-hand turn, the left-hand wheel 4L is lowered while the right-hand wheel 4R is lifted. In flying mode, both wheels are lowered so that the cabin 2 as a whole is lifted, as will be explained in more detail later.

[0013] When the vehicle is airborne, it is desirable that it has a tail with at least one upright tail plane with a longitudinal orientation, the tail being at a relatively large distance from the cabin, to enhance the aerodynamic stability with a view to side wind. On the other hand, for road traffic, the longitudinal dimension of the vehicle as a whole should be as small as possible. To solve these conflicting requirements, the vehicle 1 according to the present invention comprises an extendable tail 10, as will be explained in more detail with respect to figures 3A-C.

[0014] Figure 3A is a schematic rear view of the vehicle 1, and figures 3B-C are schematic top views of the vehicle 1, the rotor being omitted here for sake of clarity. The aerodynamic shape of the vehicle 1 can clearly be seen from figures 3B-C. Specifically figure 3B shows that the cabin 2 has a rear end which is somewhat smaller than a central portion of the cabin. The extendable tail 10 has a general U-shaped profile, as seen from the rear (figure 3A), and is mounted on two longitudinal support arms 11, 12 which extend in the longitudinal direction of the vehicle. These support arms 11, 12 are received in guiding tubes 13, 14, respectively, indicated by dotted lines in figure 3B, also extending in the longitudinal direction of the vehicle, which in turn are attached to the cabin 2. The support arms 11, 12 are provided with fixing means for strongly fixing the support arms 11, 12 to the corresponding guiding tubes 13, 14; for sake of simplicity, such fixing means, which may be conventional fixing means, are not shown in the drawings. The fixing means are capable of being loosened, so that the support arms 11, 12 can slide in the corresponding guiding tubes 13, 14.

[0015] It should be noted that, in alternative embodiments, one single longitudinal support arm with corresponding single guiding tube may suffice, or the vehicle may comprise three or more longitudinal support arms with corresponding single guiding tubes.

[0016] Figure 3B shows the vehicle 1 with the support arms 11, 12 extended from the corresponding guiding tubes 13, 14, so that the tail 10 is at some distance from the rear end of the cabin 2, this distance being determined by the length of the support arms 11, 12. This is a position for flying. For road traffic, the support arms 11, 12 are shifted into the corresponding guiding tubes 13, 14, so that the tail 10 is closer to the cabin 2. In the preferred embodiment as shown, the tail 10 has a contour such that it fits with some play around the rear end of the cabin 2, so that the tail 10 does not extend beyond the cabin 2 (see figures 3A and 3C). This makes it possible to design the cabin 2 with the largest longitudinal dimension as allowed by traffic law (in many cases: 4 m) without being

restricted by a projecting tail.

[0017] At its rear end, the vehicle 1 is equipped with a propulsion device, capable of generating horizontal thrust at least when airborne, typically also while on land. The propulsion device may for instance comprise a jet engine. In the preferred embodiment as illustrated, the propulsion device comprises a propeller device 20, suitably driven by the drive motor of the vehicle or by a separate motor. The propeller 20 has a substantially horizontal propeller axle 21 and propeller blades 22. For adequate propulsion, it is desirable that the propeller blades 22 have a large length, but for road traffic the length of the propeller blades 22 is limited because it is undesirable or even not allowed that the blades extend beyond the vehicle profile. To meet both demands, the propeller 20 in accordance with the present invention has extendable blades.

[0018] In one embodiment, the propeller blades are foldable. Figure 4A is a schematic rear view of the vehicle 1, showing the propeller 20 in a folded condition; figure 4B is a similar view, now showing the propeller 20 in an extended condition. In the embodiment illustrated, the propeller 20 comprises two blades 22, but the propeller 20 may have more blades, as is known per se. Each blade 22 consists of two parts, an inner blade part 23 and an outer blade part 24, hingedly connected to each other. Alternatively, a blade may consist of three or even more parts.

[0019] In a riding mode, the propeller 20 is not driven, and the outer blade part 24 is hinged back over the inner blade part 23, so that the overall diameter of the propeller 20 in this condition is limited to substantially the diameter of the inner blade parts 23. Figure 4A shows this condition, clearly showing that the blades do not project outside the cabin contour. The blade parts 23, 24 are held in this condition by a holding member schematically indicated at 25.

[0020] In a flying mode, the propeller 20 is driven, and the outer blade part 24 is hinged to a position such that it is aligned with the inner blade part 23. In a possible embodiment, hinging the blade parts and fixing the blade parts in the folded position (figure 4A) or the extended position (figure 4B), respectively, may be a manual operation. Preferably, however, this is done automatically. To this end, the holding member 25 preferably is a resilient member, for instance a spring, which holds the corresponding blade parts when the propeller is stationary. When the propeller rotates, the outer blade part 24 experiences a centrifugal force, urging it to take a position further away from the rotation axis, against the biasing force of the resilient member 25. When the propeller is stopped, the biasing force of the resilient member 25 returns the propeller blades back to their folded condition.

[0021] It is noted that a propeller device with foldable blades is known per se. For instance, reference is made to German Offenlegungsschrift 41.19.810 to Stemme, which describes such propeller for use in a motorized glider. Since commercially available propeller devices can be used in the present invention, while further the present invention does not aim at improving such propeller device, it is not necessay here to describe the propeller device in more detail.

[0022] In an alternative embodiment, not illustrated, each propeller blade may comprise two (or more) blade parts sliding lengthwise, for instance in a telescopic manner, with respect to each other. Again, adjusting the length of the propeller blades may be done manually, but each propeller blade is preferably provided with a resilient holding and biasing member urging the outer blade part towards the propeller axis.

[0023] It is noted that figure 4B also shows that both rear wheels 4L, 4R are lowered in the flying mode. This brings the cabin 2, together with the propeller 20, to a higher level with respect to the ground. A larger distance between the rotating propeller and the ground is preferred, but not essential.

[0024] The vehicle 1 is further equipped with a rotor 40 having a rotor base 44 and foldable rotor blades 45 hingedly mounted to the rotor base 44. In the embodiment illustrated, the rotor 40 has two blades 45, but the rotor may have three or more blades. The rotor 40 is mounted on an adjustable support bracket 30; more specifically, the rotor 40 has a rotor axle 41, mounted for rotation in the bottom section 31 of the support bracket 30. The rotation axis of the rotor is indicated at 42.

[0025] The support bracket 30 has a substantially inverted U-shape, with a bottom section 31 extending substantially parallel to the cabin roof, and two leg sections 32 extending substantially parallel to the cabin sides. In an alternative embodiment, the bracket 30 may have just one leg section, so that its general shape resembles the Greek letter Γ.

[0026] The free end of the leg sections 32 are mounted to the cabin 2, in such a way that the bottom bracket part 31 with the rotor 40 can be shifted in the longitudinal direction of the vehicle. In a possible embodiment, the bracket 30 can be shifted as a whole, but in the preferred embodiment, the free end of the leg sections 32 are mounted for rotation about a horizontal transverse axis. Preferably, the bracket legs 32 comprise a parallelepiped mechanism, designed to allow the rotation movement of the bracket 30 while assuring that the rotor axis 42 remains substantially vertical.

[0027] The rotor is implemented as an auto-gyro: it rotates thanks to the air speed of the vehicle. Before take-off, the rotor is driven by a hydraulic drive, also indicated as prerotator, which is known per se. The hydraulics for this drive can be incorporated in the bracket 30.

[0028] Figures 5A, 5B and 5C are schematic side, rear and top views, respectively, of the vehicle 1 with the rotor 40 in flight condition, the tail 10 and the propeller 20 being omitted for sake of convenience. The support bracket 30 is positioned upright, so that the rotor axis 42 substantially intersects the gravitational centre (mass centre point) of the vehicle. The rotor blades 45 are in their unfolded condition; it can be seen that they extend beyond the contour

of the vehicle 1.

[0029] It is noted that, although the upright position of the support bracket 30 may be a fixed position, the bracket 30 preferably is provided with a position control mechanism actively controlling (fine tuning) the position of the support bracket 30. Thus, it is possible to adapt the position of the support bracket 30 to different weight distributions, movements of the pilot, etc, such as to maintain the rotor axis 42 intersecting the gravitational centre (mass centre point) of the vehicle.

[0030] Figures 6A and 6B are schematic side and top views, respectively, of the vehicle 1 with the rotor 40 in the condition for road traffic. Again, the tail 10 and the propeller 20 are omitted for sake of convenience. The support bracket 30 is pivoted towards the front end of the vehicle, such that the legs 32 of the bracket 30 are almost horizontal. The rotor blades 45 are pivoted with respect to the rotor base 44, such that they extend substantially parallel to each other in the longitudinal direction of the vehicle, substantially parallel to the roof of the cabin, pointing backwards from the rotor base 44. In this condition, the rotor blades lie within the contour of the vehicle.

[0031] Alternatively, it is possible that the bracket pivots towards the rear end of the vehicle, and that the rotor blades point forwards from the rotor base 44.

[0032] In order to stay within the contour of the vehicle, the maximum length of the rotor blades in their riding mode condition corresponds substantially to the length of the vehicle. Yet, for flying purposes, increased lift is desirable, which involves increased diameter of the rotor. To meet both demands, each rotor blade 45 is preferably extendable as well. In a possible embodiment, each rotor blade 45 comprises two blade sections 46, 47, hingedly connected to each other, so that, in the riding condition, an inner blade section 46 points away from the rotor base 44 to a joint 48 with the corresponding outer blade section 47, while the outer blade section 47 is pivoted with respect to the inner blade section 46 and points from this joint 48 towards the rotor base 44 again. Such configuration is illustrated in figure 6C, which only illustrates the rotor base 44 and the two-part blades 45 together with the bracket 30.

[0033] An increase in rotor diameter can also be obtained by increasing the horizontal dimension of the rotor base 44, such that the coupling points 49 of the blades 45 are located further apart, such as schematically illustrated in figure 6D, which also only illustrates the rotor base 44 and the two-part blades 45 together with the bracket 30.

[0034] It is also possible that a rotor blade 45 can be shifted along its own longitudinal direction, along a coupling bar 49. This possibility is illustrated in figure 7, which is a top view comparable to figure 5C. A coupling bar 49 extends from the rotor base 44. A rotor blade 45 can be shifted along the coupling bar 49, away from or towards the rotor base 44. A biasing means (for instance a spring, not shown) exerts a biasing force on the rotor blade 45, urging it towards the rotor base 44. In the flying mode, when the rotor rotates, the centrifugal force overcomes the biasing force, and the blade 45 is shifted to its distal position. In that case, the inner portion of the rotor 40, with a radius corresponding to the exposed coupling bar 49, does not contribute to the lifting force, but this is more than compensated by the outer portion of the rotor 40, which describes a larger area. When the rotor is stationary, the blade 45 is shifted back towards the rotor base 44 under the influence of the biasing force of said biasing means. The coupling bar 49 may then, in fact, be invisible (see figures 6A-D). In the riding mode, the blade 45 is pivoted together with the coupling bar 49 to extend in the longitudinal direction of the vehicle, as described earlier.

[0035] Alternatively, sliding the rotor blades and fixing them in position may be done manually, but the embodiment as described has the important advantage that the rotor blades are automatically positioned together, so that a risk of a positional error can be avoided.

[0036] In a further preferred embodiment as illustrated in figure 8, a rotor blade 45 comprises a hollow cylindrical passage 51 extending to a chamber 52, and the coupling bar 49 has a piston head 53 at its end, fitting in the chamber 52. The chamber 52 has an axial dimension larger than the axial dimension of the piston head 53, the difference determining the length of the possible extension of the rotor blade. The coupling bar 49 comprises hydraulics lines 54, for instance as a longitudinal bore, communicating with the chamber 52. In the riding condition, the piston head is pushed into the chamber as far as possible. For extending the rotor blade for the flying condition, hydraulic fluid is pumped into said chamber 52, pushing the bar 49 outwards as far as possible. This also provides a mechanism for holding the blade in its extended condition by maintaining the fluid pressure of the hydraulic fluid.

[0037] In the following, a journey from a start location to a target location will be described.

[0038] The driver may park the vehicle close to home, in a garage, etc. When travelling to a distant location, he will start his journey by riding away from his home, taking part in normal traffic, until he reaches a location which is suitable for take-off. Such location may be a small airfield, but it may also be a suitable parking place along a highway or the like.

[0039] The driver stops the vehicle, and switches off the motor. He unfolds the rotor blades, and fixes the blades in their folded position. Depending on design, he may manually extend the rotor blades, and fix the blades in their extended position. He brings the bracket 30 to its upright position, extends the tail, and, if desired, switches the rear wheels to their lower position. He then starts the propeller; automatically, caused by centrifugal force, the propeller blades are extended.

[0040] Finally, the driver (now pilot) starts the prerotator to give the rotor rotational speed; the vehicle is now ready for take-off.

[0041] Once airborne, the vehicle can fly towards the destination without being hindered by traffic jams. When

sufficiently close to his destination, the pilot lands the vehicle at a location which is both suitable for landing and suitably connected to the road network. He stops the propeller; automatically, the blades return to their folded position. The tail is pushed back, the wheels may be lifted to their normal position, the rotor blades are folded, and the bracket is brought to its horizontal position. The vehicle is then ready for riding in normal traffic, towards the actual destination of the driver.

[0042] It should be clear to a person skilled in the art that the present invention is not limited to the exemplary embodiments discussed above, but that several variations and modifications are possible within the protective scope of the invention as defined in the appending claims.

[0043] For instance, it is possible that rotor blades 45 are detached from the rotor base and stored in a longitudinal compartment, preferably at the bottom side of the vehicle. The same applies to the propeller blades.

[0044] In the above, a propeller is described as propulsion device. As an alternative, the vehicle may be provided with another type of propulsion device, for instance a jet engine.

Claims

1. Vehicle (1) for riding on land and flying in air, comprising:

   a cabin (2) with wheels (3; 4), the cabin (2) being designed for accommodating at least one person;
   a rotor (40) having a rotor axle (41), a rotor base (44) and rotor blades (45) mounted to the rotor base (44);
   wherein the rotor blades (45) are hingedly mounted to the rotor base (44);
   wherein the rotor blades (45) are extendable blades;
   characterized in that each rotor blade (45) is provided with a coupling member (49) attached to the rotor base (44), the rotor blade (45) being capable of shifting along said coupling member (49) in a longitudinal direction of the coupling member (49),
   wherein a rotor blade (45) comprises a hollow passage (51) extending to a chamber (52), and wherein said coupling member (49) comprises a support bar extending into said hollow
   cylindrical passage and having a piston head (53) fitting in
   said chamber (52);
   the rotor blade (45) further being provided with hydraulics for adapting the setting of the rotor blade.

2. Vehicle according to claim 1, wherein each rotor blade (45) comprises two blade sections (46, 47), hingedly connected to each other.

3. Vehicle according to claim 1 or 2, wherein the rotor blades (45) are designed to automatically take their extended condition under the influence of centrifugal force in the case of a rotating rotor.

4. Vehicle (1) for riding on land and flying in air, the vehicle comprising:

   a cabin (2) with wheels (3; 4), the cabin (2) being designed
   for accommodating at least one person;
   a rotor (40) having a rotor axle (41), a rotor base (44) and rotor blades (45) mounted to the rotor base (44);
   characterised by a support bracket (30) carrying the rotor (40), the support bracket (30) having a bottom section (31) extending substantially parallel to the cabin roof, and having at least one leg section (32) extending substantially parallel to the cabin side, the leg section (32) having a free end connected to the cabin (2);
   wherein the rotor blades (45) are hingedly mounted to the rotor base (44);
   and wherein the bottom bracket part (31) with the rotor (40) is displaceable in the longitudinal direction of the vehicle.

5. Vehicle according to claim 4, wherein the rotor blades (45) are extendable blades.

6. Vehicle according to claim 4 or 5, wherein the free end of the leg section (32) is mounted for rotation about a horizontal transverse axis.

7. Vehicle according to claim 6, wherein the bracket leg (32) comprises a parallelepiped mechanism for assuring that the rotor axis (42) remains substantially vertical.

8. Vehicle according to any of the previous claims, wherein the rotor is implemented as an auto-gyro.

9. Vehicle according to claim 8, wherein the rotor is provided with a hydraulically driven pre-rotator, wherein the hydraulics for this pre-rotator are incorporated in the bracket (30).

10. Vehicle according to any of the previous claims 6-9, having a condition for road traffic in which the support bracket (30) is displaced towards an end of the vehicle, and in which the rotor blades (45) are pivoted with respect to the rotor base (44) to a position such that they extend substantially parallel to each other in the longitudinal direction of the vehicle.

11. Vehicle according to claim 10, wherein, in the con-

dition for road traffic, the support bracket (30) is pivoted towards an end of the vehicle such that the bracket leg (32) is almost horizontal.

12. Vehicle according to any of the previous claims 4-11, having a condition for air traffic in which the support bracket (30) is held in such position, preferably an upright position, that the rotor axis (42) substantially intersects the centre of gravity (mass centre point) of the vehicle.

13. Vehicle according to claim 12, provided with a position control mechanism controlling the position of the support bracket (30) such as to adapt the position of the rotor axis (42) to changes in weight distribution, such that the rotor axis (42) remains intersecting the centre of gravity (mass centre point) of the vehicle.

14. Vehicle according to any of the previous claims, further comprising an extendable tail (10).

15. Vehicle according to claim 14, wherein the extendable tail (10) has a general U-shaped profile, as seen from the rear.

16. Vehicle according to claim 14 or 15, wherein the extendable tail (10) is mounted on at least one longitudinal support arm (11, 12) extending in the longitudinal direction of the vehicle, the support arm (11, 12) being slidably received in guiding tube (13, 14) attached to the cabin (2) and extending in the longitudinal direction of the vehicle.

17. Vehicle according to any of claims 14-15, wherein, in the condition for road traffic, the extendable tail (10) at least partly fits around the rear end of the cabin.

18. Vehicle according to any of the previous claims, further comprising, at its rear end, a propulsion means (20).

19. Vehicle according to claim 18, wherein the propulsion means comprises a propeller means (20) having a substantially horizontal propeller axle (21) and propeller blades (22).

20. Vehicle according to claim 19, wherein the propeller (20) has extendable blades (22).

21. Vehicle according to claim 20, wherein the propeller blades (22) are foldable.

22. Vehicle according to claim 21, wherein each propeller blade (22) comprises an inner blade part (23) and an outer blade part (24), hingedly connected to each other.

23. Vehicle according to claim 22, wherein, in the condition for road traffic, the outer blade part (24) is hinged back over the inner blade part (23) towards the propeller axis, whereas in the condition for air traffic, the outer blade part (24) is hinged outwards.

24. Vehicle according to claim 21, wherein each propeller blade (22) comprises an inner blade part and an outer blade part sliding lengthwise, for instance in a telescopic manner, with respect to each other.

25. Vehicle according to claim 24, wherein, in the condition for road traffic, the outer blade part is slid inwards towards the propeller axis, whereas in the condition for air traffic, the outer blade part is slid outwards.

26. Vehicle according to any of claims 22-25, wherein each propeller blade (22) is provided with a resilient holding and biasing member (25) urging the outer blade part towards the propeller axis.

27. Vehicle according to any of the previous claims 20-26, wherein the propeller blades (22) are designed to automatically take their extended condition under the influence of centrifugal force in the case of a rotating propeller.

28. Vehicle according to any of the previous claims, wherein the cabin (2) is actively tiltable around a longitudinal axis.

29. Vehicle according to claim 28, comprising one front wheel (3) or a set of front wheels located close to each other, located at the longitudinal centre line of the vehicle, arranged to be tilted along with the cabin.

30. Vehicle according to claim 28 or 29, comprising two rear wheels (4) arranged to be actively lifted or lowered with respect to the cabin, in opposite directions with respect to
each other.

31. Vehicle according to claim 30, comprising a wheel position actuator designed, in a riding mode, for lifting an inner rear wheel (4L) with respect to the cabin while simultaneously lowering the opposite outer rear wheel (4R) with respect to the cabin.

32. Vehicle according to claim 31, wherein the wheel position actuator is controlled on the basis of a force sensor sensing a road reaction force acting on the front wheel (3).

33. Vehicle according to any of claims 30-32, wherein, in flying mode, both rear wheels (4l, 4R) are lowered with respect to the cabin.

34. Vehicle according to any of claims 30-33, wherein each rear wheel (4L, 4R) is mounted on a respective arm (5L, 5R) substantially extending in the longitudinal direction of the vehicle, parallel to the side of the cabin, carrying the corresponding wheel (4L, 4R) at a rear arm end, while the front end (6L, 6R) of the arm (5L, 5R) is mounted to the cabin such as to pivot around a horizontal transverse axis.

Patentansprüche

1. Land- und Luftfahrzeug (1) mit:

einem Fahrgastraum (2) mit Rädern (3; 4), der ausgebildet ist, um zumindest eine Person aufzunehmen;
einem Rotor (40), der eine Rotorachse (41), eine Rotorbasis (44) und an der Rotorbasis (44) angebrachte Rotorblätter (45) hat;
wobei die Rotorblätter (45) an der Rotorbasis (44) gelenkig angebracht sind;
wobei die Rotorblätter (45) ausziehbare Blätter sind;
dadurch gekennzeichnet, dass jedes Rotorblatt (45) mit einem an der Rotorbasis (44) befestigten Verbindungselement (49) versehen ist, wobei das Rotorblatt (45) in der Lage ist, sich entlang des Verbindungselements (49) in eine Längsrichtung des Verbindungselements (49) zu verschieben,
wobei ein Rotorblatt (45) einen sich zu einer Kammer (52) erstreckenden Hohldurchgang (51) aufweist, und wobei das Verbindungselement (49) einen Tragbalken aufweist, der sich in den zylindrischen Hohldurchgang erstreckt und einen in die Kammer (52) passenden Kolbenboden (53) enthält;
wobei das Rotorblatt (45) weiters mit einer Hydraulik versehen ist, um die Einstellung des Rotorblattes anzupassen.

2. Fahrzeug nach Anspruch 1, wobei jedes Rotorblatt (45) zwei miteinander gelenkig verbundene Blattabschnitte (46, 47) enthält.

3. Fahrzeug nach Anspruch 1 oder 2, wobei die Rotorblätter (45) ausgebildet sind, um automatisch ihren ausgezogenen Zustand einzunehmen, wenn im Fall eines Drehrotors Zentrifugalkraft auf sie einwirkt.

4. Land- und Luftfahrzeug (1) mit:

einem Fahrgastraum (2) mit Rädern (3; 4), der ausgebildet ist, um zumindest eine Person aufzunehmen;
einem Rotor (40), der eine Rotorachse (41), eine Rotorbasis (44) und an der Rotorbasis (44) angebrachte Rotorblätter (45) hat;
gekennzeichnet durch einen den Rotor (40) tragenden Haltebügel (30), der einen sich im Wesentlichen parallel zum Dach des Fahrgastraums erstreckenden Bodenabschnitt (31) und zumindest einen sich im Wesentlichen parallel zur Seite des Fahrgastraums erstreckenden Schenkelabschnitt (32) mit einem mit dem Fahrgastraum (2) verbundenen freien Ende enthält;
wobei die Rotorblätter (45) an der Rotorbasis (44) gelenkig angebracht sind; und
wobei der Bodenabschnitt (31) des Bügels mit dem Rotor (40) in Längsrichtung des Fahrzeugs verschiebbar ist.

5. Fahrzeug nach Anspruch 4, wobei die Rotorblätter (45) ausziehbare Blätter sind.

6. Fahrzeug nach Anspruch 4 oder 5, wobei das freie Ende des Schenkelabschnitts (32) zur Drehung um eine horizontale Querachse angebracht ist.

7. Fahrzeug nach Anspruch 6, wobei der Bügel-Schenkel (32) einen parallelepipedischen Mechanismus aufweist, um sicherzustellen, dass die Rotorachse (42) im Wesentlichen vertikal bleibt.

8. Fahrzeug nach einem der vorherigen Ansprüche, wobei der Rotor als Tragschrauber umgesetzt ist.

9. Fahrzeug nach Anspruch 8, wobei der Rotor mit einem hydraulisch angetriebenen Vor-Rotator versehen ist, wobei die Hydraulik für diesen Vor-Rotator in den Bügel (30) eingebaut ist.

10. Fahrzeug nach einem der Ansprüche 6 bis 9, das einen Straßenverkehrszustand aufweist, bei dem der Haltebügel (30) hin zu einem Ende des Fahrzeugs verschoben ist, und bei dem die Rotorblätter (45) in Bezug auf die Rotorbasis (44) in eine Position geschwenkt sind, so dass sie sich im Wesentlichen parallel zueinander in Längsrichtung des Fahrzeugs erstrecken.

11. Fahrzeug nach Anspruch 10, wobei der Haltebügel (30) im Straßenverkehrszustand hin zu einem Ende des Fahrzeugs geschwenkt ist, so dass der Bügel-Schenkel (32) beinahe horizontal ist.

12. Fahrzeug nach einem der Ansprüche 4 bis 11, das einen Luftverkehrszustand aufweist, bei dem der Haltebügel (30) in einer solchen Position, vorzugsweise in einer Hochkantposition, gehalten wird, dass die Rotorachse (42) das Schwerkraftzentrum (den Massemittelpunkt) des Fahrzeugs im Wesentlichen schneidet.

13. Fahrzeug nach Anspruch 12, das mit einem Positi-

onssteuermechanismus versehen ist, der die Position des Haltebügels (30) steuert, um die Position der Rotorachse (42) zur Änderung der Gewichtsverteilung anzupassen, so dass die Rotorachse (42) das Schwerkraftzentrum (den Massemittelpunkt) des Fahrzeugs weiterhin schneidet.

14. Fahrzeug nach einem der vorherigen Ansprüche, das weiters ein ausziehbares Ende (10) enthält.

15. Fahrzeug nach Anspruch 14, wobei das ausziehbare Ende (10) von hinten gesehen ein allgemein U-förmiges Profil aufweist.

16. Fahrzeug nach Anspruch 14 oder 15, wobei das ausziehbare Ende (10) an zumindest einem Längs-Tragarm (11, 12) angebracht ist, der sich in die Längsrichtung des Fahrzeugs erstreckt und in einem Führungsrohr (13, 14) schiebbar aufgenommen ist, wobei das Führungsrohr (13, 14) am Fahrgastraum (2) befestigt ist und sich in die Längsrichtung des Fahrzeugs erstreckt.

17. Fahrzeug nach Anspruch 14 oder 15, wobei das ausziehbare Ende (10) im Straßenverkehrszustand zumindest teilweise um das Hinterende des Fahrgastraums passt.

18. Fahrzeug nach einem der vorherigen Ansprüche, das an seinem Hinterende weiters ein Antriebsmittel (20) aufweist.

19. Fahrzeug nach Anspruch 18, wobei das Antriebsmittel aus einem Propellermittel (20) mit einer im Wesentlichen horizontalen Propellerachse (21) und Propellerblättern (22) besteht.

20. Fahrzug nach Anspruch 19, wobei der Propeller (20) ausziehbare Blätter (22) enthält.

21. Fahrzeug nach Anspruch 20, wobei die Propellerblätter (22) zusammenklappbar sind.

22. Fahrzeug nach Anspruch 21, wobei jedes Propellerblatt (22) einen inneren Blattteil (23) und einen äußeren Blattteil (24) enthält, die miteinander gelenkig verbunden sind.

23. Fahrzeug nach Anspruch 22, wobei der äußere Blattteil (24) im Straßenverkehrszustand nach hinten über den inneren Blattteil (23) hin zur Propellerachse geschwenkt ist, wogegen der äußere Blattteil (24) im Luftverkehrszustand nach außen geschwenkt ist.

24. Fahrzeug nach Anspruch 21, wobei jedes Propellerblatt (22) einen inneren Blattteil und einen äußeren Blattteil enthält, die in Bezug aufeinander in Längsrichtung, beispielsweise teleskopartig, gleiten.

25. Fahrzeug nach Anspruch 24, wobei der äußere Blattteil im Straßenverkehrszustand nach innen hin zur Propellerachse geschoben ist, wogegen der äußere Blattteil im Luftverkehrszustand nach außen geschoben ist.

26. Fahrzeug nach einem der Ansprüche 22 bis 25, wobei jedes Propellerblatt (22) mit einem flexiblen Halte- und Vorspannelement (25) versehen ist, das den äußeren Blattteil hin zur Propellerachse drängt.

27. Fahrzeug nach einem der Ansprüche 20 bis 26, wobei die Propellerblätter (22) ausgebildet sind, um automatisch ihren ausgezogenen Zustand einzunehmen, wenn im Fall eines Drehpropellers Zentrifugalkraft auf sie einwirkt.

28. Fahrzeug nach einem der vorherigen Ansprüche, wobei der Fahrgastraum (2) um eine Längsachse aktiv kippbar ist.

29. Fahrzeug nach Anspruch 28, das ein Vorderrad (3) oder einen Satz Vorderräder enthält, die nah nebeneinander angeordnet sind, an der Längsmittellinie des Fahrzeugs, um mit dem Fahrgastraum gekippt zu werden.

30. Fahrzeug nach Anspruch 28 oder 29, das zwei Hinterräder (4) enthält, die angeordnet sind, um in Bezug auf den Fahrgastraum in zueinander entgegengesetzte Richtungen aktiv gehoben oder gesenkt zu werden.

31. Fahrzeug nach Anspruch 30, das ein Radpositions-Betätigungsmittel enthält, das im Fahrmodus ausgebildet ist, um ein inneres Hinterrad (4L) in Bezug auf den Fahrgastraum zu heben, während es das gegenüberliegende äußere Hinterrad (4R) in Bezug auf den Fahrgastraum gleichzeitig senkt.

32. Fahrzeug nach Anspruch 31, wobei das Radpositions-Betätigungsmittel basierend auf einem Kraftsensor gesteuert wird, der eine auf das Vorderrad (3) wirkende Straßenreaktionskraft misst.

33. Fahrzeug nach einem der Ansprüche 30 bis 32, wobei beide Hinterräder (4L, 4R) in Bezug auf den Fahrgastraum im Flugmodus gesenkt sind.

34. Fahrzeug nach einem der Ansprüche 30 bis 33, wobei jedes Hinterrad (4L, 4R) auf einem jeweiligen Arm (5L, 5R) angebracht ist, der sich im Wesentlichen in Längsrichtung des Fahrzeugs, parallel zur Seite des Fahrgastraums erstreckt und das entsprechende Rad (4L, 4R) an einem hinteren Armende trägt, während das vordere Ende (6L, 6R) des Arms (5L, 5R) zum Schwenken um eine horizontale Querachse am Fahrgastraum angebracht ist.

Revendications

1. Véhicule (1) permettant de rouler sur terre et de voler dans l'air, comprenant :

une cabine (2) munie de roues (3 ; 4), la cabine (2) étant conçue pour recevoir au moins une personne ;
un rotor (40) comportant un axe de rotor (41), une base de rotor (44) et des pales de rotor (45) montées sur la base de rotor (44) ;
dans lequel les pales de rotor (45) sont montées de manière articulée sur la base de rotor (44) ;
dans lequel les pales de rotor (45) sont des pales extensibles ;
caractérisé en ce que chaque pale de rotor (45) est pourvue d'un élément d'accouplement (49) fixé à la base du rotor (44), la pale de rotor (45) étant capable de se déplacer le long dudit élément d'accouplement (49) dans une direction longitudinale de l'élément d'accouplement (49) ;
dans lequel une pale de rotor (45) comprend un passage creux (51) s'étendant jusqu'à une chambre (52), et dans lequel ledit élément d'accouplement (49) comprend une barre de support s'étendant dans ledit passage cylindrique creux et comportant une tête de piston (53) montée dans ladite chambre (52) ;
la pale de rotor (45) étant en outre pourvue d'une partie hydraulique pour adapter le réglage de la pale de rotor.

2. Véhicule selon la revendication 1, dans lequel chaque pale de rotor (45) comprend deux portions de pale (46, 47), connectées l'une à l'autre de manière articulée.

3. Véhicule selon la revendication 1 ou 2, dans lequel les pales de rotor (45) sont conçues pour prendre automatiquement leur état étendu sous l'influence de la force centrifuge engendrée par le rotor en rotation.

4. Véhicule (1) permettant de rouler sur terre et de voler dans l'air, le véhicule comprenant :

une cabine (2) munie de roues (3 ; 4), la cabine (2) étant conçue pour recevoir au moins une personne ;
un rotor (40) comportant un axe de rotor (41), une base de rotor (44) et des pales de rotor (45) montées sur la base de rotor (44) ;
caractérisé par un élément de support (30) supportant le rotor (40), l'élément de support (30) ayant une portion inférieure (31) s'étendant sensiblement parallèlement au toit de la cabine, et comportant au moins une branche (32) s'étendant sensiblement parallèlement au côté de la cabine, la branche (32) ayant une extrémité libre connectée à la cabine (2) ;
dans lequel les pales de rotor (45) sont montées de manière articulée sur la base de rotor (44) ;
et dans lequel la partie de support inférieure (31) avec le rotor (40) peut être déplacée dans la direction longitudinale du véhicule.

5. Véhicule selon la revendication 4, dans lequel les pales de rotor (45) sont des pales extensibles.

6. Véhicule selon la revendication 4 ou 5, dans lequel l'extrémité libre de la branche (32) est montée à rotation autour d'un axe transversal horizontal.

7. Véhicule selon la revendication 6, dans lequel la branche de support (32) comprend un mécanisme parallélépipédique pour assurer que l'axe de rotor (42) reste sensiblement vertical.

8. Véhicule selon l'une quelconque des revendications précédentes, dans lequel le rotor est mis en oeuvre sur un autogire.

9. Véhicule selon la revendication 8, dans lequel le rotor est pourvu d'un dispositif de pré-rotation hydraulique, dans lequel le circuit hydraulique pour ce dispositif de pré-rotation est incorporé dans le support (30).

10. Véhicule selon l'une quelconque des revendications 6 à 9, ayant un état pour la circulation routière dans lequel l'élément de support (30) est déplacé vers une extrémité du véhicule, et dans lequel on fait pivoter les pales de rotor (45) par rapport à la base de rotor (44) jusqu'à une position dans laquelle elles s'étendent sensiblement parallèlement entre elles dans la direction longitudinale du véhicule.

11. Véhicule selon la revendication 10, dans lequel, dans l'état pour la circulation routière, on fait pivoter l'élément de support (30) vers une extrémité du véhicule de telle manière que la branche de support (32) est presque horizontale.

12. Véhicule selon l'une quelconque des revendications 4 à 11, ayant un état pour la circulation aérienne dans lequel l'élément de support (30) est maintenu dans une position, de préférence une position debout, telle que l'axe de rotor (42) coupe substantiellement le centre de gravité (centre de masse) du véhicule.

13. Véhicule selon la revendication 12, pourvu d'un mécanisme de commande de position qui commande la position de l'élément de support (30) de manière à adapter la position de l'axe de rotor (42) à des changements de la répartition du poids, de telle ma-

nière que l'axe de rotor (42) continue de passer par le centre de gravité (centre de masse) du véhicule.

14. Véhicule selon l'une quelconque des revendications précédentes, comprenant en outre une queue extensible (10).

15. Véhicule selon la revendication 14, dans lequel la queue extensible (10) a un profil général en forme de U, vu de l'arrière.

16. Véhicule selon la revendication 14 ou 15, dans lequel la queue extensible (10) est montée sur au moins un bras de support longitudinal (11, 12) s'étendant dans la direction longitudinale du véhicule, le bras de support (11, 12) étant reçu de façon glissante dans un tube de guidage (13, 14) solidaire de la cabine (2) et s'étendant dans la direction longitudinale du véhicule.

17. Véhicule selon l'une quelconque des revendications 14 à 15, dans lequel, dans l'état pour la circulation routière, la queue extensible (10) s'emboîte au moins partiellement autour de l'extrémité arrière de la cabine.

18. Véhicule selon l'une quelconque des revendications précédentes, comprenant en outre, à son extrémité arrière, un moyen de propulsion (20).

19. Véhicule selon la revendication 18, dans lequel le moyen de propulsion comprend une hélice (20) ayant un axe d'hélice sensiblement horizontal (21) et des pales d'hélice (22).

20. Véhicule selon la revendication 19, dans lequel l'hélice (20) a des pales extensibles (22).

21. Véhicule selon la revendication 20, dans lequel les pales d'hélice (22) sont pliables.

22. Véhicule selon la revendication 21, dans lequel chaque pale d'hélice (22) comprend une partie de pale intérieure (23) et une partie de pale extérieure (24), connectées l'une à l'autre de manière articulée.

23. Véhicule selon la revendication 22, dans lequel, dans l'état pour la circulation routière, la partie de pale extérieure (24) est articulée pour se replier sur la partie de pale intérieure (23) vers l'axe d'hélice, tandis que dans l'état pour la circulation aérienne, la partie de pale extérieure (24) est dépliée vers l'extérieur.

24. Véhicule selon la revendication 21, dans lequel chaque pale d'hélice (22) comprend une partie de pale intérieure et une partie de pale extérieure qui glissent dans le sens de la longueur, par exemple de manière télescopique, l'une par rapport à l'autre.

25. Véhicule selon la revendication 24, dans lequel, dans l'état pour la circulation routière, la partie de pale extérieure est glissée vers l'intérieur, en direction de l'axe d'hélice, tandis que dans l'état pour la circulation aérienne, la partie de pale extérieure est glissée vers l'extérieur.

26. Véhicule selon l'une quelconque des revendications 22 à 25, dans lequel chaque pale d'hélice (22) est pourvue d'un élément résilient de maintien et de sollicitation (25) qui pousse la partie de pale extérieure vers l'axe d'hélice.

27. Véhicule selon l'une quelconque des revendications 20 à 26, dans lequel les pales d'hélice (22) sont conçues pour prendre automatiquement leur état étendu sous l'influence de la force centrifuge générée par l'hélice en rotation.

28. Véhicule selon l'une quelconque des revendications précédentes, dans lequel la cabine (2) peut être inclinée de manière active autour d'un axe longitudinal.

29. Véhicule selon la revendication 28, comprenant une roue avant (3) ou un ensemble de roues avant proches les unes des autres, située sur l'axe longitudinal du véhicule, et adaptée pour être inclinée avec la cabine.

30. Véhicule selon la revendication 28 ou 29, comprenant deux roues arrière (4) adaptées pour être levées ou abaissées de manière active par rapport à la cabine, dans des directions opposées l'une par rapport à l'autre.

31. Véhicule selon la revendication 30, comprenant un actionneur de position de roue conçu, dans un mode de conduite terrestre, pour lever une roue arrière intérieure (4L) par rapport à la cabine tout en abaissant la roue arrière extérieure opposée (4R) par rapport à la cabine.

32. Véhicule selon la revendication 31, dans lequel l'actionneur de position de roue est commandé en se basant sur un capteur de force qui mesure une force de réaction de route agissant sur la roue avant (3).

33. Véhicule selon l'une quelconque des revendications 30 à 32, dans lequel, en mode de vol, les deux roues arrière (41, 4R) sont abaissées par rapport à la cabine.

34. Véhicule selon l'une quelconque des revendications 30 à 33, dans lequel chaque roue arrière (4L, 4R) est montée sur un bras respectif (5L, 5R) s'étendant

sensiblement dans la direction longitudinale du véhicule, parallèle au côté de la cabine, supportant la roue correspondante (4L, 4R) à une extrémité de bras arrière, tandis que l'extrémité avant (6L, 6R) du bras (5L, 5R) est montée sur la cabine de manière à pivoter autour d'un axe transversal horizontal.

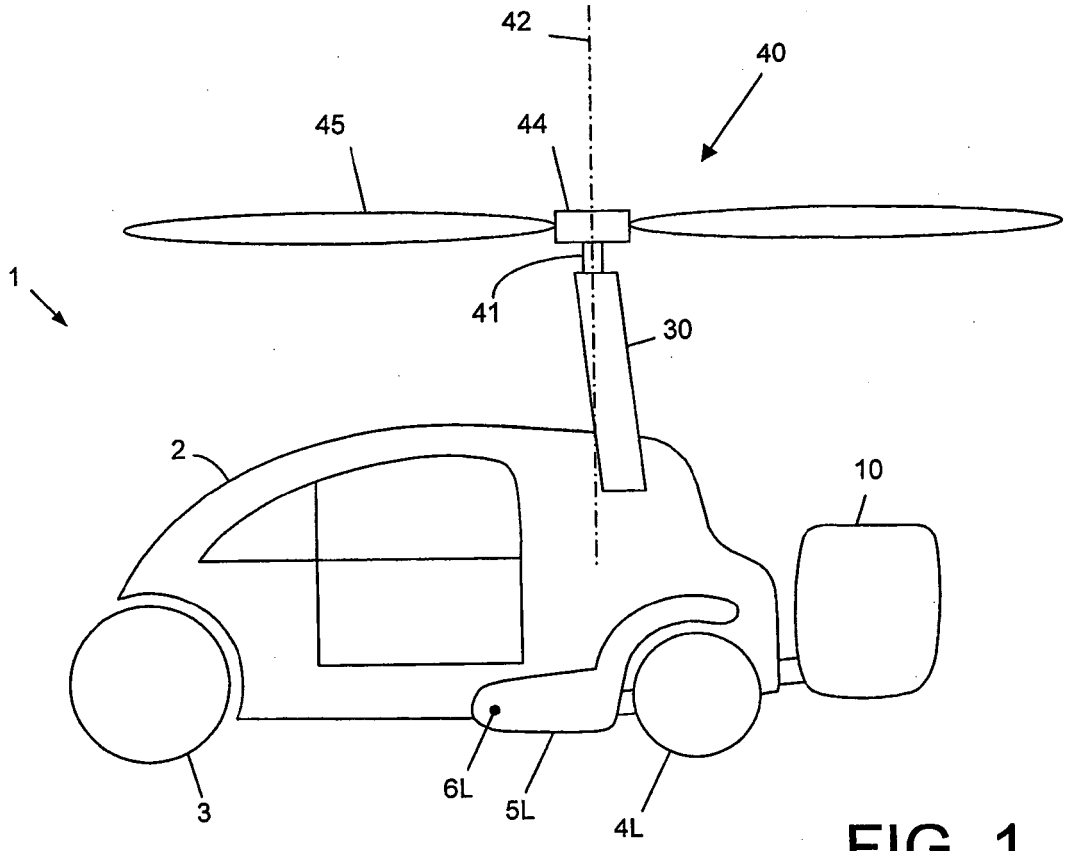

FIG. 1

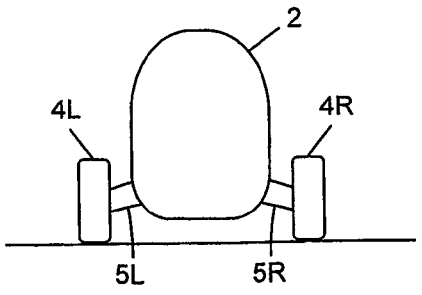

FIG. 2A

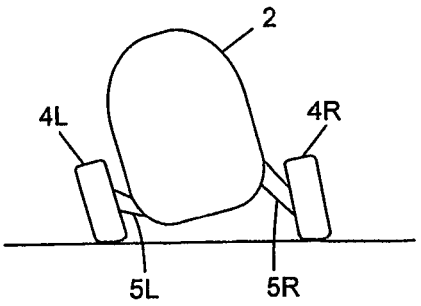

FIG. 2B

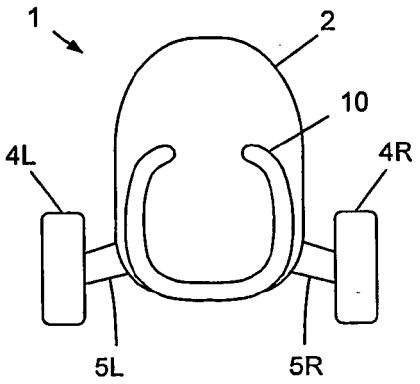

FIG. 3A

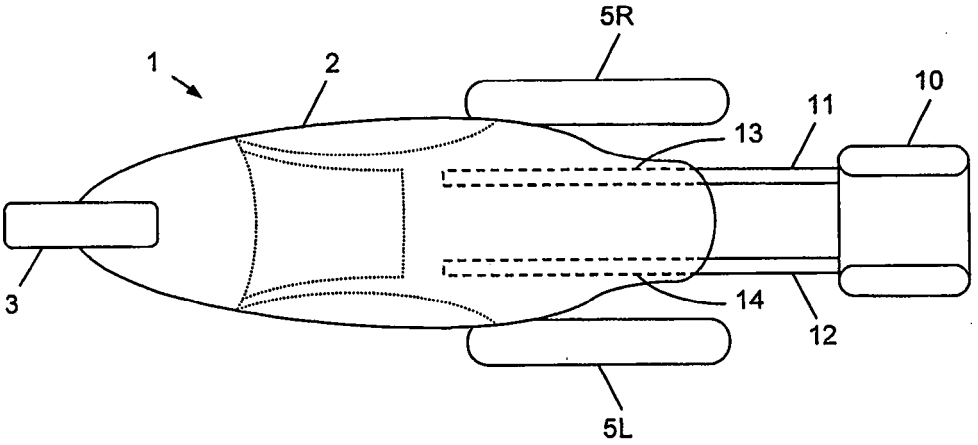

FIG. 3B

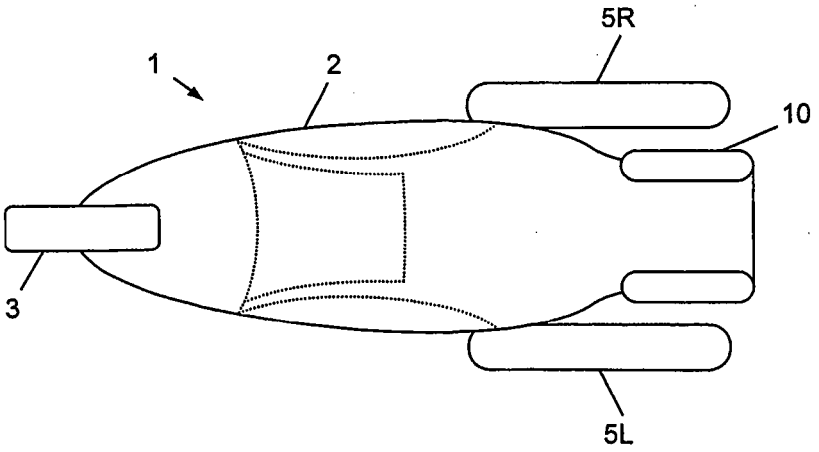

FIG. 3C

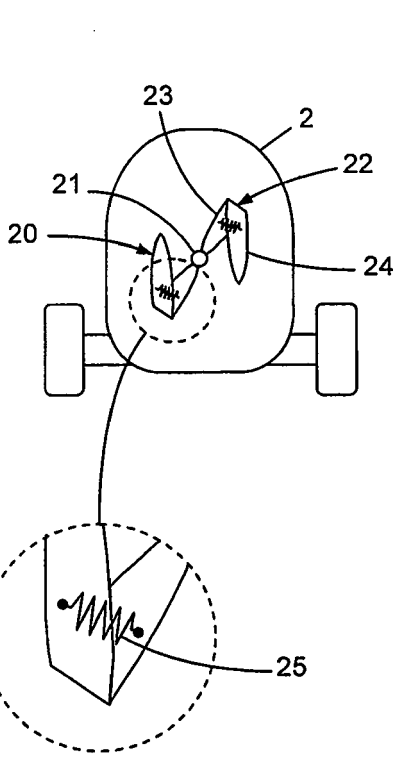

FIG. 4A

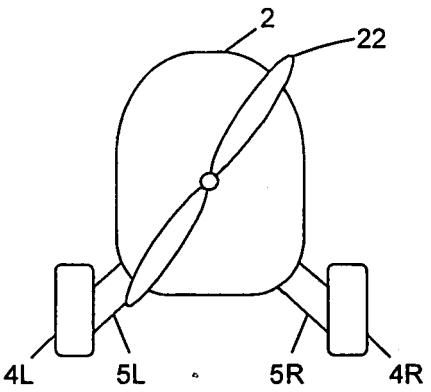

FIG. 4B

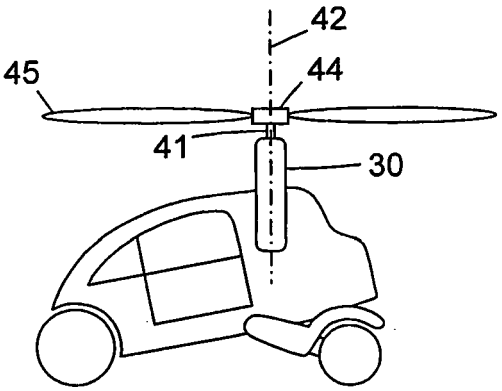

FIG. 5A

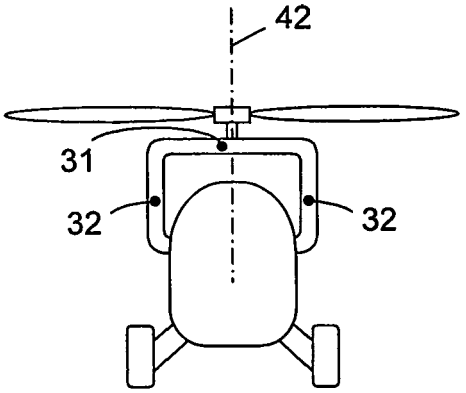

FIG. 5B

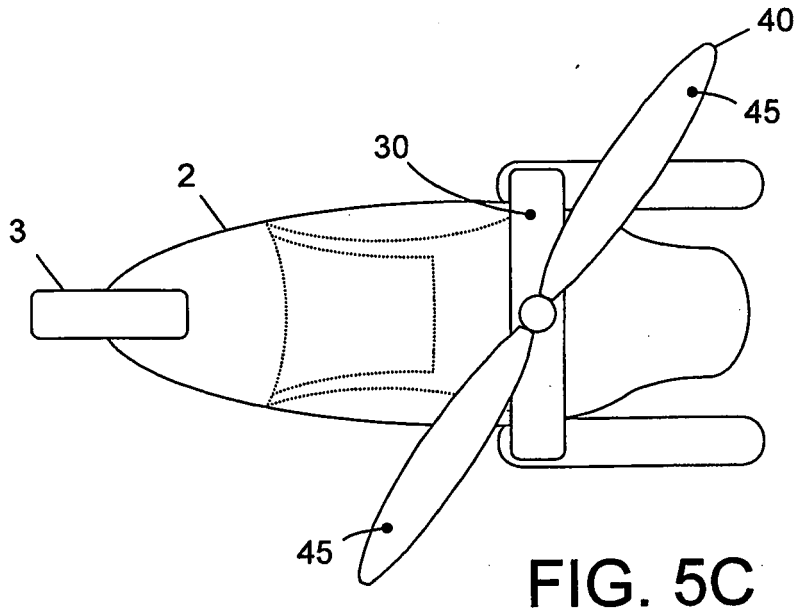

FIG. 5C

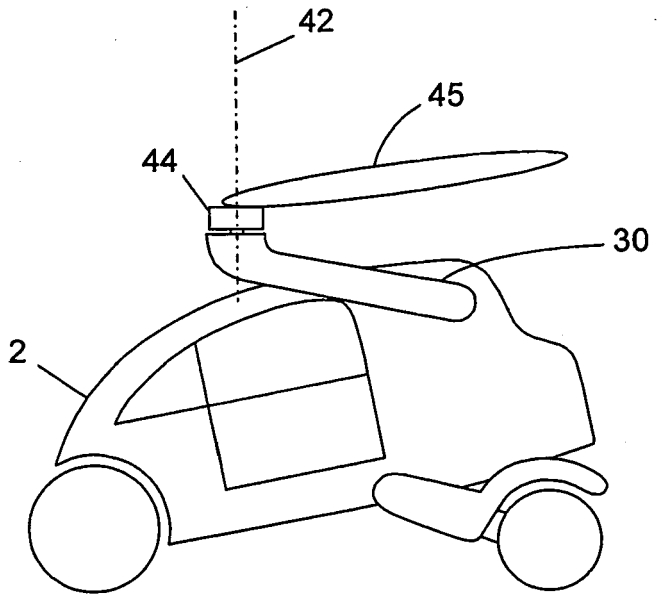

FIG. 6A

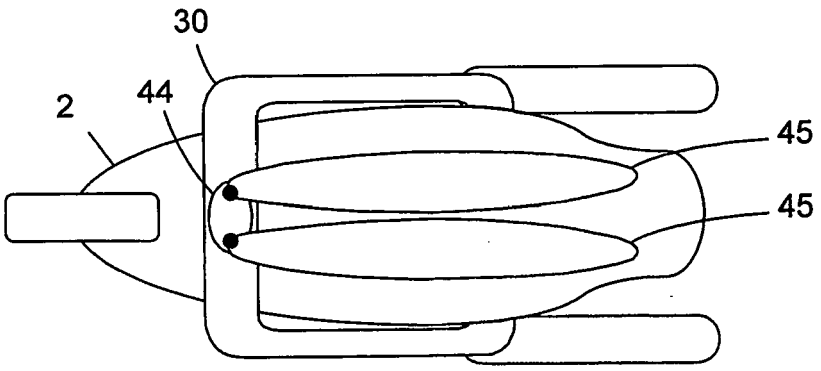

FIG. 6B

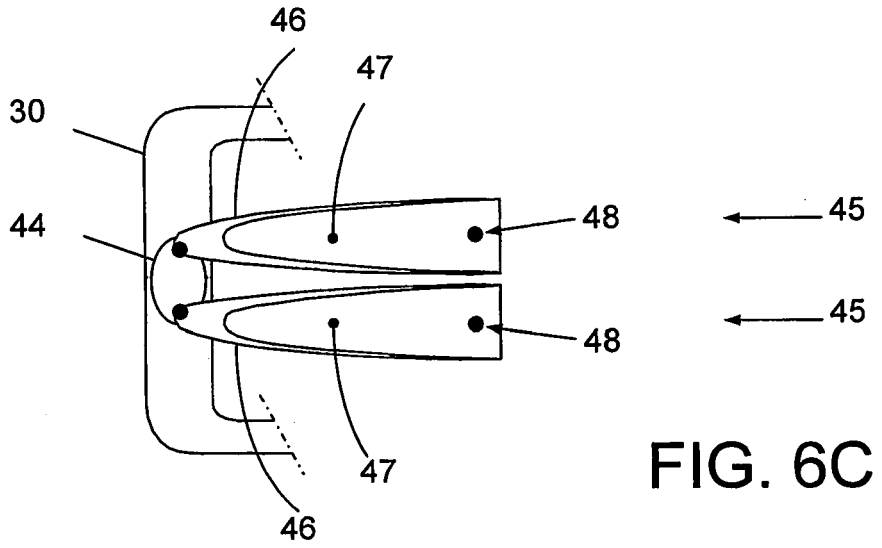

FIG. 6C

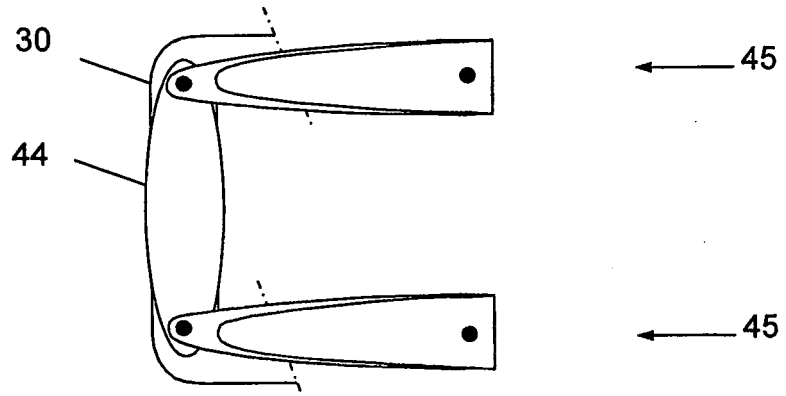

FIG. 6D

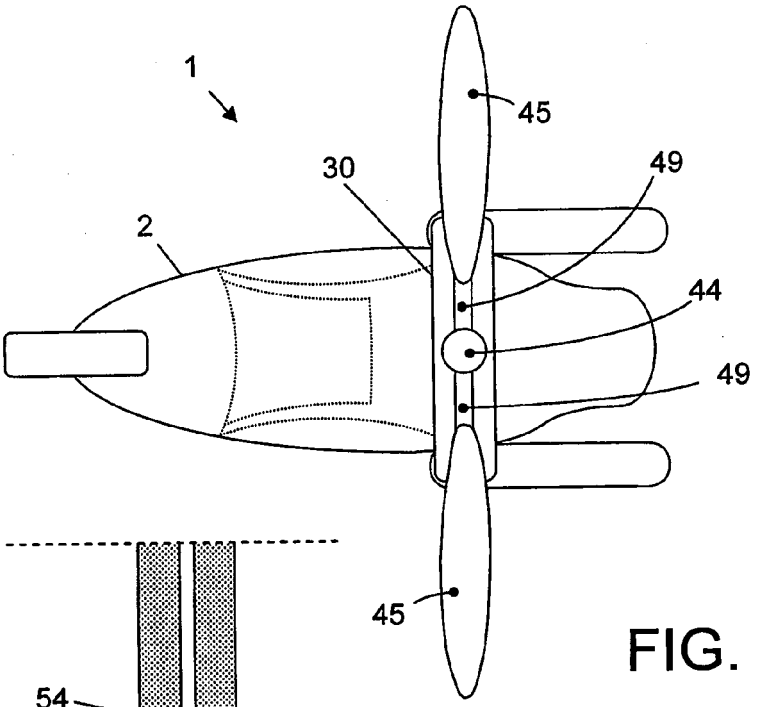

FIG. 7

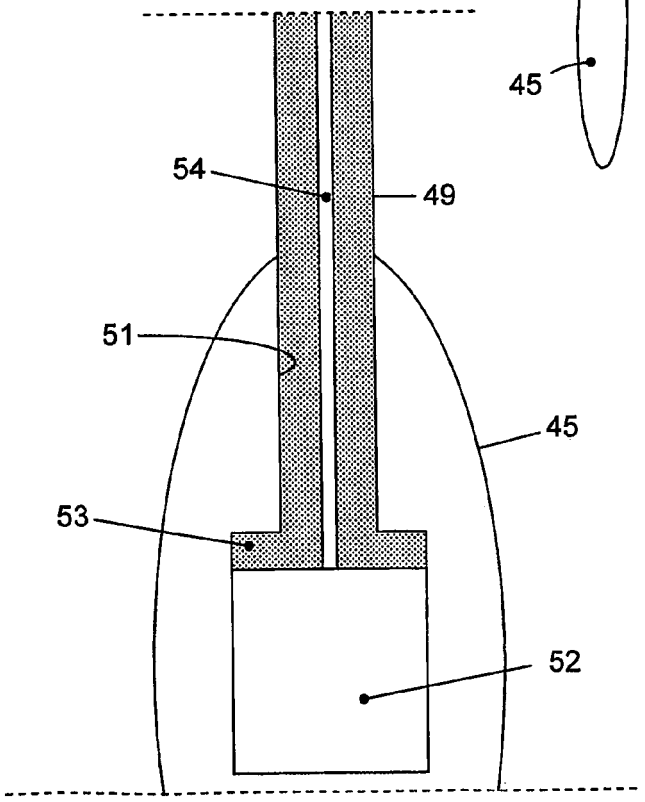

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 10159082 **[0002] [0010]**
- US 3771923 A **[0003]**
- US 5927424 A **[0010] [0011]**
- DE 4119810 **[0021]**