AERIAL NAVIGATION APPARATUS

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Inventor:
E. E. Oehmichen

Attorney:
AERIAL NAVIGATION APPARATUS

Etienne Edmond Oehmichen, Valen
tigney, France

Application October 8, 1934, Serial No. 747,469
In France October 23, 1933

9 Claims. (Cl. 244—17)

I have filed applications in France on October
23, 1933 and October 21, 1933.

The present invention has for its object a navi-
gation apparatus with static stabilization and
high efficiency of security capable of effecting
at the will of the pilot, vertical, horizontal or in-
clined flight.

The static stabilization and the security are ob-
tained by means of a stabilizing and security wing
formed by a flexible envelope inflated with air and
provided with ailerons according to the features
which are set out in detail hereinafter.

Moreover, one or more auxiliary propellers are
provided to develop a couple capable of opposing
the static couple of correction which tends to
bring the centre of volume to the vertical of the
general centre of gravity.

Instead of auxiliary propellers the same result
may be obtained by the displacement of ballast
which modifies the position of the general centre
of gravity in the interior of the apparatus.

Finally shock absorbers are provided so that the
apparatus may land freely without mishap.

The exact part to be played by the various
parts of the apparatus and their operation will be
readily understood from the description of the ac-
companying drawings which show, by way of ex-
ample diagrammatically, forms of construction of
apparatus according to the invention.

In these drawings:

Fig. 1 shows an apparatus provided with two
sustaining and propelling screws and with a single
auxiliary propeller, seen from underneath in per-
spective after starting or at the moment of vertical
landing with the use of the engine.

Figs. 2 to 10 are explanatory diagrams of the
action of the stabilizing and security wing.

Fig. 11 shows the apparatus of Fig. 1 resting on
the ground.

Fig. 12 shows the same apparatus in horizontal
flight.

Fig. 13 is a modification of the apparatus in
Fig. 1 as regards the position of the auxiliary
propeller.

Fig. 14 shows an apparatus in horizontal flight
with movable ballast for changing the position of
the general centre of gravity.

As will be seen in Figs. 1, 11, and 12, the appa-
ratus is provided with a flexible wing inflated with
air, hereinafter referred to as "wing envelope" 1
with an axis X—X'. This wing has ailerons 6 and
6a, fins 7 and 7a (the latter being hidden by the
cabin 11 and chassis 9). The engine is indicated at
10. A vertical fin 8 is provided at the top. Two sus-
taining propellers 2 and 2' are placed symmetri-
cally relatively to a vertical line passing through
X—X' and their rotating axes make a certain
perpendicular angle passing through X—X' as
will be seen hereinafter. The auxiliary propeller
is indicated at 3. Shock absorbers are provided at
4, 4' and 5. S, S' indicates the horizontal ground
line. Finally 12 and 12' is an inclined landing
device.

The security and stabilizing wing envelope is
constructed according to the experiments of the
applicant on the basis of the following con-
siderations:

It will be noted that all bodies which are floating
in a fluid are subjected to a static pressure equal
to the weight of the fluid which they displace.

Therefore a body tends to assume a position of
stable equilibrium whenever the general centre
of gravity of the body is not coincident with the
centre of the Archimedean thrust. The body
therefore left in any kind of position tends to
turn until the centre of thrust is at the vertical
of the centre of gravity and above it.

This tendency also becomes manifest whenever
the body is denser than the fluid into which it is
dropped, reaction members, such as sustaining
screws, being used for preventing it from falling.

In this case the body is subjected to its proper
weight and to the reactions which the centre
exerts thereon and the Archimedean thrust may
then manifest its effects on the general equi-
lbrium.

On the other hand it is well known that re-
volving tapered bodies offer a resistance to move-
ment in a fluid which differs considerably accord-
ing as to whether the movement takes place along
the axis of the body or in a perpendicular direc-
tion. Thus the envelope of a dirigible balloon of
well selected outline has but a weak resistance to
forward movement along its axis while the resis-
tance to vertical ascent or to the descent is very
high. Experiments of the applicant have shown
that for equal movement the transverse resist-
ance may amount up to hundred times that of the
resistance to the movement along the axis and
that it can retard the descent of the apparatus by

using, devices of a construction which render more difficult the circulation of air from the bottom upwards around the envelope, whilst only slightly opposing forward movement.

The applicant has found that it is possible to provide an envelope of a shape similar to that of dirigible balloons, which are simply filled with atmospheric air, provided with ailerons, having a suitably selected shape and position, impart to the whole qualities comparable with those of an ordinary aeroplane wing.

The fundamental feature of a good aeroplane wing is a span much greater than its width. The fineness of a wing, that is to say the ratio between the supporting force and the resistance to forward movement, increases in fact with the lengthening in the transverse direction. A wing of good quality should have a length at least equal to four times the width.

The applicant has found by experience that the same conditions did not apply when the supporting wings are associated with a tapered envelope similar to that of dirigibles. Very small ailerons, of much less length in the direction of span than depth in the longitudinal direction and connected at an angle to the envelope produce for the whole qualities of fineness comparable with those of a good aeroplane, that is to say an increased supporting power for a slight resistance to forward movement.

If, in Fig. 2, A is the distance between the tips of the ailerons, B the diameter of the envelope between the ailerons, the fineness of the whole is comparable with that of the aeroplane (Fig. 3) having a span A with a wing of depth L, the aileron having a length equal to B. For the ailerons the length is approximately

\[ A - B \approx \frac{L}{2} \]

and for the aeroplane wing:

\[ A = L' \]

It will be seen that L is infinitely smaller than L'. The acknowledged device is advantageous, the ailerons only project slightly from the envelope and their false span is insignificant. The securing of the same to the envelope is easy as for the horizontal fins of a dirigible with a flexible envelope. It suffices that the inflation pressure of the envelope is sufficient to stretch the surface to the required degree and to give the necessary rigidity.

The ailerons 6 and 6' (Fig. 4) are connected to the envelope by stays E (Fig. 5) operating under extension and compression and attached to rigid head ropes Rz secured in the envelope itself.

The presence of ailerons and that of the fins 1 and 1', which the wing should normally be provided with, necessarily increases the resistance of the envelope to any vertical movement, that is to say perpendicular to the axis of the envelope and to the plane of the ailerons. The flexible envelope is inflated with air, provided with ailerons surrounding the apparatus in Fig. 1 provided with propellers, thus permits of obtaining:

1. An aerodynamic sustentation of the same order as that of an aeroplane of the same span, with a resistance to forward movement comparable with that of the aeroplane and consequently an equal quality of inclined flight.

2. A stabilization by the action of the Archimedian thrust when the general centre of gravity G (the weight of the inflating air of the envelope intervening for the calculation of this pressure) is below the centre of static thrust, which is substantially at the centre of volume V of the envelope.

3. The total security in this direction that if the mechanical sustaining power should fail, the apparatus tends, by its construction, to descend vertically provided that the horizontal fins have a depth rudder which extends them sufficiently so that when they are raised upwards the apparatus does not have a tendency to plunge. The entire device descends somewhat like a parachute and the resistance made by the envelope against the air in descending may be made such that the speed of fall does not reach an excess to the absorption capacity of the landing device.

The closed fuselage of an aeroplane evidently plays a part comparable with that of the wing envelope, but the centre of volume being almost coincident with the general centre of gravity, there is no return stabilizing couple by static pressure, and the volume is too small to enable the stabilizing pressure to intervene usefully. Thus an aeroplane cannot descend vertically in a stable manner for various reasons.

In Figs. 4 and 5 it will be seen that the ailerons 6, and 6' have a movable rear portion 6'1 or 6'2 like the depth rudders 1'1 and 1'2 of the fins 1 and 2. In order that the ailerons may fulfil their purpose it is necessary, irrespective of the movement of the apparatus, that the resultant of the aerodynamic actions which act thereon may always be adjacent the general centre of gravity G, which is on the vertical of the centre of static pressure V or the centre of volume of the envelope inflated with air.

In dirigibles normally travelling horizontally the fins which stabilize the apparatus attack the air at a zero theoretical angle and therefore their supporting power is also zero. On the contrary during vertical descent the fins attack the air at an angle of 90° and their part is important. In this case the resultant of the aerodynamic actions tends to move rearwardly but will also tend to oppose the centre of pressure of the wind on the ailerons when passing from horizontal to vertical descent. The resultant R during horizontal traveling (Fig. 6) tends to move to R' during vertical descent. When again moving upwardly the movable parts 1'1 and 1'2 of the fins 1 and 1', the resultant is moved to R'' (Fig. 7).

It is always much simpler to make the fixed planes of the rear fin supporting by giving them a suitable angle of incidence. The resultant R is then hardly ever displaced when passing from one direction of travel to another.

It is even possible to obtain an effect similar to that of wings in tandem of old apparatus of the type known as "duck". For this purpose it suffices that the angle of incidence \( \alpha \) of the fins (Fig. 8) be less by some degrees than the angle \( \alpha \) of the ailerons and that the surface S of the fins (Fig. 9) is greater by an amount given to the surface F of the ailerons. A great stability is thus obtained, which increases the steadiness during flight, whilst at the same time ensuring a fixity of position of the resultant R during vertical descent.

The intense circulation of air around the envelope necessitates, as has been shown by tests,
that in order to obtain a good penetration, the ailerons should be provided with receding surfaces, a shape which is fundamentally different from that of ordinary aeroplane wings.

5 As the ailerons and fins are carried by the envelope the lower space of the apparatus is entirely free which permits of the use of sustaining screws which can freely repel the air towards the base without projecting it on to any obstacle and particularly without influencing the supporting elements placed towards the rear. It is in fact impossible to place supporting surfaces, behind sustaining screws not only lower than these, but even on the same level. The ejection of air by the sustaining screw, rotating about the axis 00' (Fig. 10) considerably deforms the aerodynamic field of the apparatus assumed to be travelling horizontally. The streams of air are immediately deviated downwards for a considerable depth E of the field and only resume a horizontal direction a very long distance behind the screw.

Any surface in the deviated zone or any downwardly deflected zone is thus subjected to a decreasing component. Some consideration might be based on this fact if the aerodynamic field remained constant at the point at which the element is located, but this is not the case as should the velocity of the displacing air vary relatively to one another, then the deviation also varies.

When the speed of the apparatus changes the angle of deviation changes at the same time and the same effect is also produced when the effort of the sustaining system varies by reason of modifying the incidence of its blades or its speed of rotation.

It is therefore generally not possible to place an element having an actual supporting surface in the deviated zone, without running the risk of considerable unequilibrium. It is therefore necessary to place extremely far back the supporting element located at the rear of the apparatus so as to escape the deviation, or they are placed at a level above that at which the screw operates.

These conditions cannot be fulfilled with ordinary wings at the level or above the sustaining screws. They are obtained perfectly with the wing envelope above described which, in order to fly the sustaining part should also be raised to as much as possible relatively to the general centre of gravity and consequently relatively to the propelling and sustaining screws which are necessarily sufficiently close to this same centre.

To ensure the security of the wing envelope, it is necessary that with a span comparable with that of an aeroplane of the same carrying power, the retardation of descent to a sufficiently low vertical speed is ensured so that a sufficiently light landing gear may be applied to the apparatus which can sufficiently absorb the kinetic energy of the latter. In fact for a total span A of 10 meters, (Fig. 2) a diameter B of the envelope of 4.50 metres, and by suitably adjusting the length and the surfaces of the fins the speed of descent can be limited to 6 metres per second for a weight of 600 kg. the ordinary shock absorber of very short stroke of an apparatus of the "Helicostats" type constructed and tested by the applicant have permitted landing normal to the vertical for a speed of descent of 4.50 metres per second and a total weight of 500 kg. It therefore suffices to have for this absorber 2½ times as large to deaden, without damage, the fall of an apparatus with wing envelope. The current technique of the engineer will enable him to effect this without difficulty.

For these same dimensions as mentioned above the air wing envelope ensures a static stability which is entirely sufficient when the general centre of gravity is sufficiently low and when the carrying power of the apparatus exceeds 5 times the resistance to flight. The stabilizing and safety wing produces equilibrium of the apparatus under all conditions by reason of the static pressure independently of the speed of translation.

It is not absolutely necessary to enclose the mass of air filling the wing envelope in a fluid tight manner. It suffices to cause this mass of air to consolidate itself sufficiently with the apparatus so that the major portion thereof partsakes of all the movements. This same condition is realized in hemispherical parachutes having no central outflow flu for the air. The air enclosed in the hemisphere parachute cannot escape freely and there remains at the bottom a certain quantity which is not renewed and which should be considered as being consolidated with the parachute of which it consequently considerably raises the centre of gravity.

It is for this reason, as has been shown by the applicant, that the oscillations of a parachute, instead of taking place about the apparent centre of gravity, very near that of the passenger, take place at a point much nearer the hemisphere of the parachute. This point is the general centre of gravity and the air, consolidated with the parachute, intervenes by its mass and this centre is at a much higher level than if the air of the hemisphere had been properly evacuated.

The mechanism which permits of obtaining at will vertical, horizontal or inclined flight is constructed on the basis of the following principles;—

The apparatus adapted for vertical flight should be provided with sustaining screws driven by powerful engines, which requires very heavy transmissions for the movements of the propellers.

The apparatus should also have propelling means for moving it horizontally.

The first solution which presents itself is that of propellers of which the axis of rotation can be inclined relatively to the main body of the apparatus and thus obtained at will a sustaining force with or without a horizontal translating component.

This combination has never given good results as it applies to a mechanism, which is already complex in itself, the complication of the variable inclining system acting on the shafts subjected to intense driving couples and gyroscopic reactions. The apparatus is made considerably heavier and its fragility is increased.

It is also necessary to cause the shafts of the sustaining screws to pivot about a horizontal axis passing through the general centre of gravity of the apparatus and perpendicular to the plane of symmetry. This condition cannot be carried out in practice with an apparatus surmounted by an envelope as the general centre of gravity is raised too much.

In other apparatus known as "Helicostats", invented and constructed by the applicant, the 70 axes of rotation of the propellers variously inclined to a fixed post are simply caused to converge in such a manner that the said axes all bear on the horizontal of the centre of gravity. The pitch of the propellers is then caused to 75
vary differently and there is finally obtained a resultant of variable intensity and direction but always passing through the general centre of gravity or an adjacent fixed point.

In the apparatus, forming the object of the present invention, the wing envelope as already described is connected indifferently to the chassis. The general centre of gravity of the whole (including in its calculation the air filling in the envelope) is on the vertical of the static centre of pressure of the air on the entire apparatus, with the axis of the wing envelope horizontal.

The sustaining propellers 2 and 2' are placed symmetrically relative to the vertical line X-X' and the axis of rotation Y-Y' of each screw makes an angle \( \alpha \) with the line of the track X-X' (Fig. 11). The aerostatic centre of pressure is easily confused with the centre of volume V of the wing envelope, the other elements of the apparatus being almost negligible relative to that of the volume.

A double landing gear is provided with two elements 4 and 4' which are symmetrical relative in line to the plane of symmetry of the apparatus and which is preferably inclined in order to obtain a certain spreading. The directions of the telescoping of the two elements are in a line perpendicular to the lines of symmetry of the apparatus and to the end line X-X'. This telescoping line is therefore vertical when X-X' horizontal and it passes through the general centre of gravity G.

At the rear is provided a shock absorber 5, preferably of pneumatic type, formed of a very resistant envelope lined at the bottom with one or more flexible protecting sheets to increase its resistance to punctures and tearing without destroying its pliability.

When the apparatus rests on the ground it rests on the shock absorbers 4, 4', and 5. The vertical of G then falls in the interior of the triangle 4, 4', and 5. The centre of volume V is to the rear of the vertical of G and the axis of the propellers 2, 2' should be vertical. Consequently the angle \( \alpha \) on line Y-Y' to the line X-X is the complement of the angle \( \beta \) which is made by the directions X-X and S-S and which expresses the degree of rising of the apparatus or inclination of the axis of wing envelope to the horizontal.

If the apparatus has only sustaining screws 2 and 2', and when these develop a force \( \mathbf{P} \) greater than or equal to the weight \( \mathbf{P} \) of the apparatus, the latter rises, but the apparatus immediately rocks under the action of the pressure developing the couple \( \mathbf{e} \times \mathbf{Gp} \) in the direction of the arrow C'.

In order to keep the apparatus raised it is necessary to apply there to a couple in the direction of arrow C equal to that acting along but in the opposite direction. This is the part of the auxiliary screw 3 which is generally of variable pitch. The pitch is adjusted at a value such that the force \( f \) developed by 3 gives a couple \( \mathbf{f} \times \mathbf{Gp'} \) equal in absolute value to the rocking couple but in the opposite direction.

As long as the screw 3 develops the force \( f \) the apparatus remains raised, that is to say that the screws 2, 2' act vertically or almost so without producing any horizontal component thrust, when it is only the very low value adapted to compensate the recoil force due to the very small retrograde component of the screw 3. This component is generally so weak that it may almost be neglected in practice.

If the force \( f \) produced by 3 decreases the couple \( \mathbf{f} \times \mathbf{Gp'} \) also decreases. The stabilizing couple \( \mathbf{e} \times \mathbf{Gp} \) becomes preponderant and the apparatus tends to descend, that is to say reduces its rising. When \( f \) is nil, V comes on the vertical of G and the axis X-X' is horizontal. At this moment the sustaining screws 2, 2' secured to the apparatus, are inclined to the vertical. A horizontal component therefore appears and the apparatus begins to move. The apparatus then occupies the position in Fig. 12 and travels horizontally at a high speed and if there is any reduction or increase in the vertical component of the resistant by the sustaining screws, the ailerons with which the wing envelope is provided, or the simple normal positive or negative pressure exerted on the wing envelope suffices to compensate the variation.

For landing the pitch of the screw 3 or horizontal fins, or both, are acted upon. The apparatus immediately tilts and loses its speed until this speed becomes zero. The speed of the engine is then moderated in such a way that the force \( \mathbf{P} \) becomes smaller than \( \mathbf{P} \) and the descent takes place vertically with good stability, by reason of the presence of the wing envelope. Contact with the ground is made by means of the landing gears 4, 4', and 5 as when starting.

When in the apparatus there occurs a stoppage that the engine stalls or a breakage occurs in the mechanism two cases arise:

1. When the apparatus has stopped at the moment of the failure of the force \( \mathbf{P} \) the apparatus will descend vertically under the action of gravity, and is stabilized same as a parachute by the envelope 1. The shock absorbers of long stroke 4, 4' operate in the exact direction of the shock at the moment of contact with the ground and they are calculated so that the negative acceleration of absorbing does not exceed four times the normal acceleration of the weight.

2. When the apparatus is in motion, the speed should be stopped immediately or at a short distance before reaching the ground by operating the rudders of the horizontal fins, and the movable parts such as \( \gamma \) (Fig. 1). If the ailerons are provided with movable parts \( \gamma ' \) and \( \gamma '' \) their action may be of additional help. After this operation the tilling takes place and the apparatus descends vertically as stated before.

In the two cases the movable parts of the fins remain raised during the entire descent, otherwise the apparatus would tend to nose dive, which would cause a moving speed to appear. In this case the descent would be inclined same as in an aeroplane, this it is endeavoured to avoid at least before coming into contact with the ground.

The landing train 4, 4' can remain spread out, but it is preferable to collapse the same during horizontal flight, on account of the same offers during flight. When a landing is to be effected the motor having stopped, during the vertical descent the landing train will again be spread out ready for landing on the ground. It will be found that during the descent the landing train will offer no resistance, which it would during horizontal flight.

This landing gear forms a double absorbing clutch \( \mathbf{G} \) for 4th stroke and may be constructed in any desired manner. Its useful absorbing stroke will have a constant braking of at least 0.06 metre. Such a landing gear may be constructed solidly and at a relatively reduced weight.

The propeller 3 may be placed in various ways...
provided that it develops a couple equal and opposite to the aerostatic return couple due to the thrust when the inclination is such that the horizontal component of 2 and 2' is annulled.

As a rule makers are a little more complicated than has already been said, it may happen that when the apparatus is at an inclination at which the axis of the sustaining screws is vertical a horizontal component is produced by the auxiliary screw. This is seen in Fig. 12, and 3 is placed as in Figs. 1, 11 and 12, but this is not so when the position shown in Fig. 13 is selected, which meanwhile permits of starting flight and landing without any horizontal component of translation. It suffices in fact for $JGp'$ to be equal to $s \times Gp'$ (equivalent to $f$) is vertical and equal to $P$ ($P'$ is the resultant of the forces of the main supporting screws) (6).

This will thus be seen that the inclination of $F'$ to the axis $X-X'$ should not be rigorously equal to the complement of the angle formed by $X-X'$ and $S-S'$. It is also slightly stronger for the purpose of compensating the effect of the horizontal component of the propeller.

In summary the whole arrangement is the following in all cases.

When the apparatus with its wing envelope rests on the ground in the tilted position the vertical of the general centre of gravity naturally falls in the interior of the triangle 4, 4', 5, the system of propellers being set in operation gives rise to a general vertical or substantially vertical resultant. This resultant makes with the axis of the wing envelope a complementary or substantially complementary angle to the angle of tilting of the apparatus. This rests on the ground on a landing device and on the rear absorber generally carried by the wing envelope.

The plane of telescoping defined previously contains the straight line $G, V$.

The purpose of the propellers such as 3 is particularly to develop a couple capable of opposing the static straightening couple which tends to bring the point $V$ to the vertical of $G$. It is therefore possible to obtain theoretically the same result by moving the ballast such as water, or by the use of a movable weight (which may be at 55).

A useful part of the apparatus movable along a straight line parallel to $X-X'$ such as $Z-Z'$ (Fig. 14).

The motion of this weight modifies the position of $G$ in the interior of the apparatus and tends to bring the point $V$ to the vertical of $G$, passing if necessary through the intermediate positions and stopping when the movable weights $p$ occupy the positions $p'$ or $p''$ respectively.

The rear shock absorber only serves when starting and landing at the tilted position whilst using the engine. It may therefore be of much shorter stroke than those of the front shock absorbers and should consequently be subjected to the shock which the apparatus meets when coming vertically in contact with the ground, braked in its fall solely by the transverse resistance of the envelope.

The absorber 5 may have a shape of less resistance to penetration and may act efficiently during flight as pneumatic fin thus reducing the vertical feeling.

Finally the apparatus is provided with landing gears which permit the apparatus to easily slide to the ground. Of these the main landing 75 gear is kept unsprung, which will cause the apparatus to rest in an inclined position on the inclined landing devices 12, 12'.

The wing envelope not only stabilizes itself by the action of the couple due to the Archimedean thrust, but also when for example the apparatus tends to incline laterally, that is, turns around parallel axis $X-X$ (Fig. 12) this inclination immediately produces a motion spreading to one side under the action of the screws. This spreading is translated by a very violent reaction of the air on the wing envelope as it tends to move it laterally therefore perpendicularly to its major axis. It is well known that the envelope opposes to this motion a resistance which is at its maximum when the motion is perpendicular to its major axis.

The effect is not the same longitudinally, that is to say in the direction of travel with a tapered envelope.

If the apparatus is flying on a fixed point, that is, neither advancing nor retreating, it is not possible to count on any straightening action. No reaction of the air on the apparatus will be produced when the apparatus is immovable. If the apparatus tends to nose down, it tends to tilt upward, the couple due to the static pressure will tend to stabilize the device. The screw 3 then plays an important part, and aids to provide and furnish at the will of the pilot intense stabilizing couples.

The screw 5 may in fact, with blades of variable incidence and reversibility, develop forces in one direction or the other and can thus consequently correct any defective position assumed by the apparatus.

The apparatus is never stationary for a long time. It is stationary only when starting or in landing the device or in very exceptional cases. The pilot therefore has only to operate the engine for a few seconds in order to balance the device either for rising or for landing. When the apparatus has started, the action of the screw 3 is stopped by stopping it or by placing its blades at zero incidence. The apparatus flattens itself immediately, takes up a horizontal position and enters into translation. The fins then add to the static stabilizing couple their own stabilizing action which increases with the speed of the apparatus.

During vertical descent the wing envelope is stabilized in all directions. Its position of steady equilibrium by aerodynamic reaction is obtained when the axis of wing envelope is perpendicular to the motion in the air, that is to say in the case when this axis is horizontal. The aerodynamic straightening effect therefore coincides with the couple due to the static pressure for re-establishing equilibrium of the apparatus.

There immediately results a very high degree of safety for the apparatus as no matter what position the apparatus occupies it suffices in order to cause the apparatus to descend to moderate the action of the sustaining screws by reducing the speed of the engine. The apparatus will then stabilize itself exactly like a parachute, by placing the axis of the wing envelope in a horizontal position.

What I claim is:

1. An aerial navigation apparatus comprising a light wing envelope having the shape of a tapered body of great penetration and inflated with 70 air; a chassis; means connecting the wing envelope to the chassis; sustaining and propelling means fixed to the chassis; lateral ailerons on the envelope which form an acute angle of incidence with a generally horizontal plane passing 75
through the longitudinal axis of the envelope; lateral tail fin units on the envelope which form a smaller angle than the former; movable parts on the rear side of the ailerons and of the tail fin surfaces; the whole of the apparatus having a general centre of gravity under the centre of aerostatic pressure.

2. An aerial navigation apparatus comprising a light hollow wing envelope having the shape of a tapered body of great penetration and inflated with air; partly free, an open envelope; a chassis; means connecting the wing envelope to the chassis; sustaining and propelling means fixed to the chassis; lateral ailerons on the envelope which form an acute angle of incidence with a generally horizontal plane passing through the longitudinal axis of the envelope; lateral tail fin units on the envelope which form a smaller angle than the former; movable parts on the rear side of the ailerons and on the tail fin units; the whole of the apparatus having a general centre of gravity under the centre of aerostatic pressure.

3. An aerial navigation apparatus comprising a light hollow wing envelope having the shape of a tapered body of great penetration and inflated with air; a chassis; means connecting the wing envelope to the chassis; sustaining and propelling means of unvarying position with respect to the chassis, their axis being inclined to and forming an angle with the plane of the longitudinal axis of the envelope, complementary to the stopping angle of the apparatus resting on the ground, the propelling means developing forces of a vertical resultant; lateral ailerons on the envelope which form an angle with the plane of the longitudinal axis of the envelope; lateral tail fin surfaces on the envelope which form a smaller angle than the former; movable parts on the rear side of the ailerons and of the tail fin surfaces; the whole of the apparatus having a general centre of gravity under the centre of aerostatic pressure.

4. An aerial navigation apparatus comprising a light hollow wing envelope having the shape of a tapered body of great penetration and inflated with air; a chassis; means connecting the wing envelope to the chassis; sustaining and propelling means of unvarying position with respect to the chassis, their axis being inclined to and forming an angle with the plane of the longitudinal axis of the envelope, substantially complementary to the stopping angle of the apparatus resting on the ground, the propelling means developing forces of a substantially horizontal resultant; lateral ailerons on the envelope which form an angle with the plane of longitudinal axis of the envelope; lateral tail surfaces on the envelope which form a smaller angle than the former; movable parts on the rear side of the ailerons and of the tail surfaces; the whole of the apparatus having a general centre of gravity under the centre of aerostatic pressure.

5. An aerial navigation apparatus comprising a light hollow wing envelope having the shape of a tapered body of great penetration and inflated with air; a chassis; means connecting the wing envelope to the chassis; sustaining and propelling means of unvarying position with respect to the chassis, their axis being inclined to and forming an angle with the plane of the longitudinal axis of the envelope, complementary to the stopping angle of the apparatus resting on the ground, the lifting means developing forces of a vertical resultant; lateral ailerons on the envelope which form an angle with the plane of the longitudinal axis of the envelope; lateral tail fin surfaces on the envelope which form a smaller angle than the former; movable parts on the rear side of the ailerons and of the tail fin surfaces; the whole of the apparatus having a general centre of gravity under the centre of aerostatic pressure.
rest on the ground in the stopped position; the whole of the apparatus having a general centre of gravity under the centre of aerostatic pressure.

9. An aerial navigation apparatus comprising a light hollow wing envelope having the shape of a tapered body of great penetration and inflated with air; a chassis; means connecting the wing envelope to the chassis; sustaining and propelling means of unvarying position with respect to the chassis, their axis being inclined to and forming an angle with the plane of the longitudinal axis of the envelope, complementary to the stopping angle of the apparatus resting on the ground, the propelling means developing forces of a horizontal resultant; lateral ailerons on the envelope which form an angle with the plane of the longitudinal axis of the envelope; lateral tail surfaces on the envelope which form an angle which is smaller than the former; movable parts on the rear side of the ailerons and of the tail surfaces; landing shock absorbers of long stroke, the direction of the telescoping being loxodromic with respect to the plane of symmetry of the apparatus, but in a plane which is perpendicular to the longitudinal axis of the envelope; a rear shock absorber for enabling the apparatus to rest on the ground in stopped position; means permitting to eclipse the said shock absorbers; an oblique landing device or undercarriage similar to that of an aeroplane; the whole of the apparatus having a general centre of gravity under the centre of aerostatic pressure.

ETIENNE EDMOND OEHMICHEN.