

Sept. 15, 1964

M. J. G. MANIFICAT
CAPTIVE FLYING PLATFORM UNIT

3,148,847

Filed Sept. 19, 1962

4 Sheets-Sheet 1

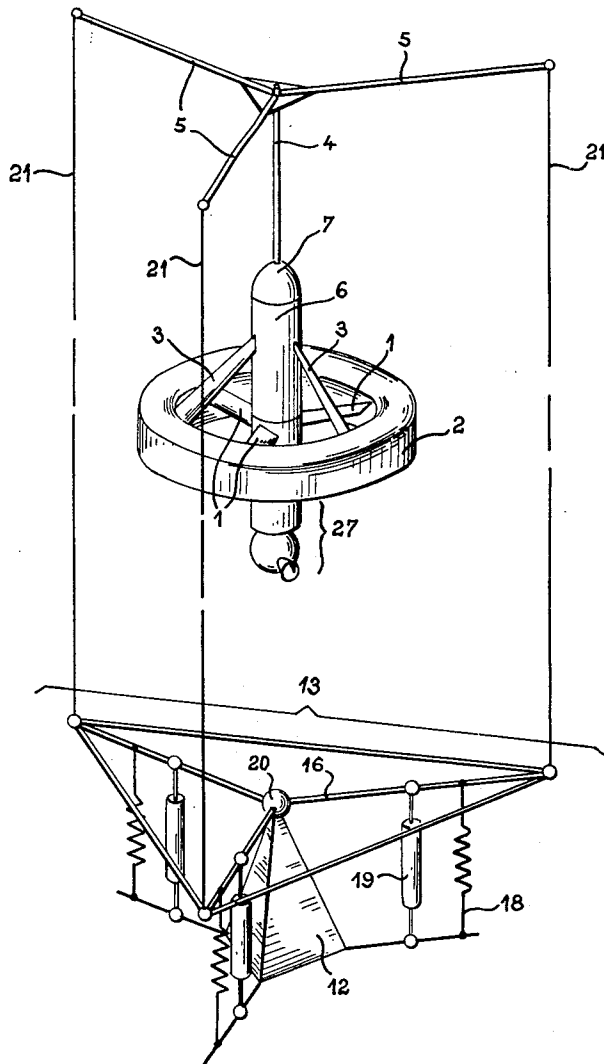


Fig. 1.

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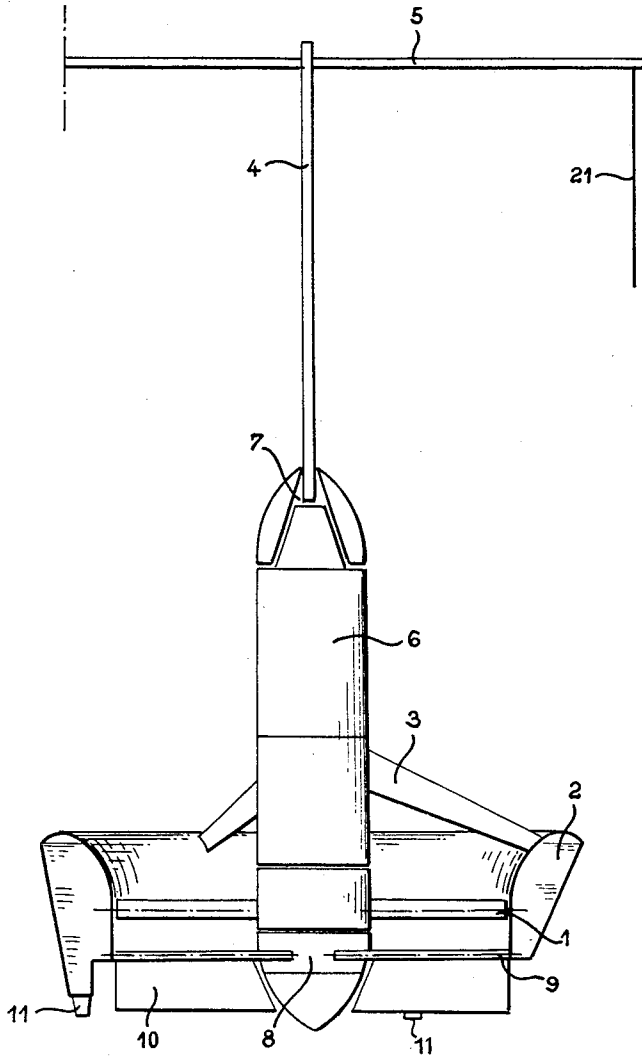


FIG. 2

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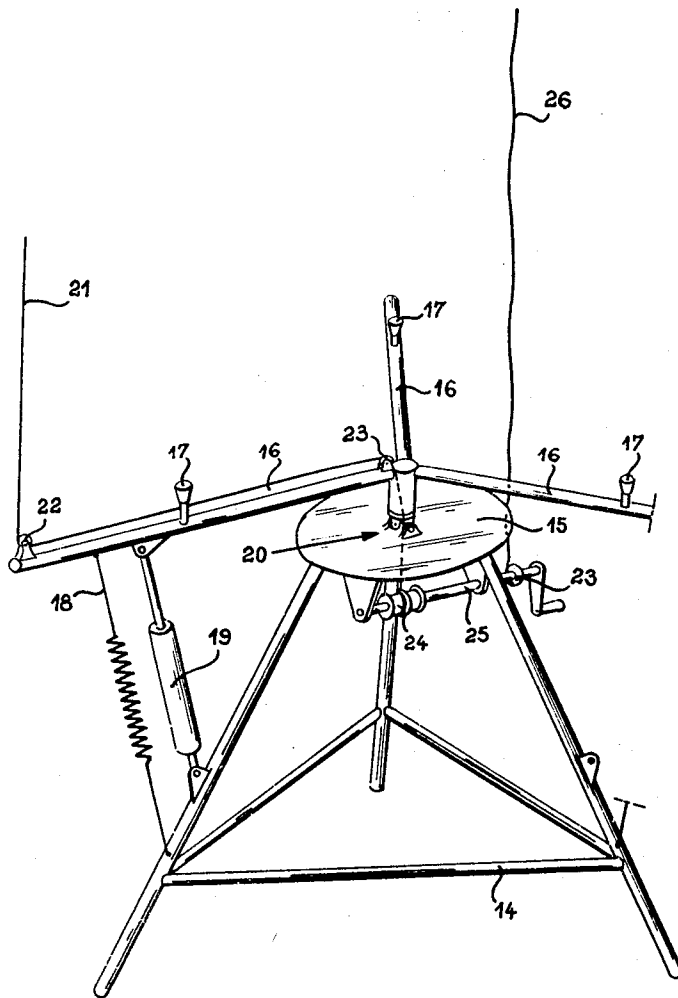


Fig. 3

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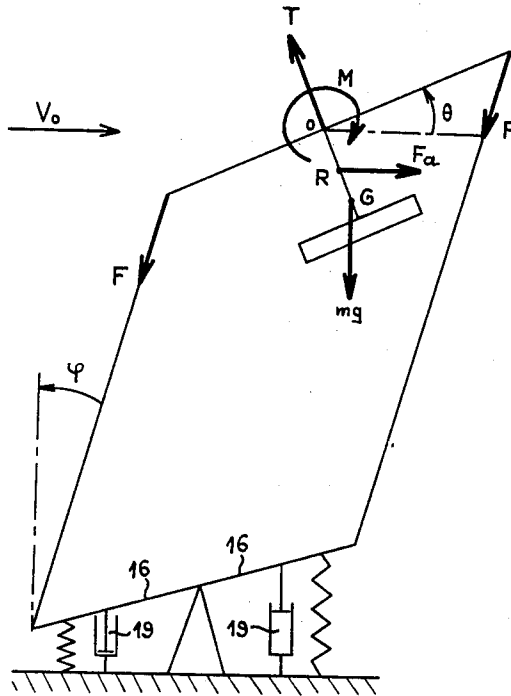


FIG. 4

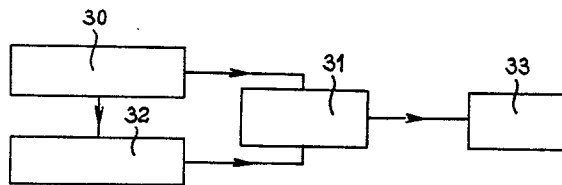


FIG. 5

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3,148,847

CAPTIVE FLYING PLATFORM UNIT

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Claims priority, application France, Jan. 30, 1962, 886,410

16 Claims. (Cl. 244—17.17)

The present invention relates to a captive flying platform unit together with its operating and control system.

Captive aerial devices which have been most frequently employed up to the present time were captive balloons, in which the lifting force is of aerostatic origin. They have very numerous drawbacks: they are bulky, vulnerable, difficult to apply and to handle from the ground, etc.

Apparatus of the kite type has also been utilized, in which the lifting force is of aerodynamic origin and results from the velocity of the wind at the place of location. The variations in wind speed render these devices difficult to employ in practice.

The present invention has for its object a captive flying platform unit which does not have these disadvantages.

It essentially comprises a platform aerodynamically placed and held in the air and the corresponding aerodynamic lifting means, a station on the ground comprising a fixed base and a rigid frame articulated about a point on the said base, a series of at least three parallel metal cables of equal length and not in the same plane coupling the said platform to the said rigid frame, and means for simultaneously varying the length of the said metal cables.

In one preferred embodiment of the platform according to the invention, the aerodynamic lifting means utilized are constituted by a vertical-shaft faired air-screw, the flying platform comprising deflecting flaps to prevent the fairing from being rotated in the opposite direction to the air-screw. These flaps may furthermore be commanded from a fixed azimuth reference.

Other lifting means may be contemplated, for example a turbo-jet engine which replaces both the faired air-screw and its driving motor.

The captive flying platform unit according to the invention is of small overall size, and is not very vulnerable. It can be rapidly put into service and is stable and easy to control.

The station on the ground may be installed on a self-propelled vehicle, which is particularly interesting for military application.

Other features and advantages will be apparent from the description which follows below of one preferred embodiment of the invention, reference being made to the accompanying diagrammatic drawings, in which:

FIG. 1 is a view in perspective of the whole of the captive flying platform unit in operation;

FIG. 2 is a longitudinal vertical section of the flying platform;

FIG. 3 is a perspective view of a ground station;

FIG. 4 is a sketch which shows the static and dynamic stability of the flying platform;

FIG. 5 is a diagram of the control for commanding the flying platform from a given azimuth reference.

In the drawings, the aerodynamically-lifted platform comprises essentially an air-screw 1 rotating in the fairing 2, and a central member attached to the fairing by stays 3. The central member comprises a central vertical strut 4, to the upper part of which three radial arms 5 are rigidly secured at 120° to each other, and the outer stator of an electric motor 6, the shaft of which drives

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the air-screw 1, directly or through reduction gearing. The strut 4 and the stator 6 are coupled to each other by a mechanical part 7 of any desired type.

The lower end of the driving shaft of the air-screw 1 is enclosed by a bearing 8 which is connected to the fairing 2 by spokes 9, on which are articulated flaps 10 to compensate for the torque created by the air-screw on the fairing 2. This bearing 8 can contain a ball race which is intended to centre the extremity of the shaft of the motor 6.

Three pins 11, of which two only can be seen in FIG. 2, are arranged at regular intervals on the lower edge of the fairing 2, for a purpose which will be indicated later.

The ground station (see FIGS. 1 and 3) comprises a base 12 fixed with respect to the ground and a rigid frame 13 articulated to the said base.

The base is constituted by a kind of rigid tripod 14 provided with a small table 15 at its upper portion.

The articulated rigid frame 13 comprises essentially three radial arms 16 arranged in the same plane at 120° to each other. Each arm 16 carries a small cup 17 intended to receive the corresponding pin 11 when the flying platform is brought back to the ground. Each arm 16 is further coupled to the base 12 by means of a spring 18 and a shock-absorber 19.

The articulated rigid frame 13 is secured to the base 12 by means of a cardan joint 20.

A system of three metal cables 21 is arranged between the flying platform and the articulated rigid frame 13. Each of these cables 21 is attached to the extremity of one of the arms 5 secured to the central member of the flying platform, passes over the pulleys 22 and 23 attached to each of the arms 16 of the rigid frame, and is wound over a corresponding pulley 24 carried by a winch 25 installed below the table 15. An electric lead 26 supplying the motor 6 of the air-screw 1 is also wound on a pulley of the winch 25.

The extension 27 of the central member visible below the fairing 2 represents a casing inside which is installed a television camera.

The command controls for the platform from a given azimuth reference comprise a course station 30, supplying a difference in azimuth designated ψ , which is applied to a calculator 31. In this regard course station 30 may be any of the known devices which allow the determination of the difference in azimuth with respect to a fixed plane, said plane usually being the vertical plane passing through the magnetic North and through the center of a gyromagnetic compass, this center being one and the same with the point about which one intends to define the position of the mobile device. The difference in azimuth, such as observed at the course station, can be transmitted to any point of the mobile device where it is needed. This difference in azimuth ψ is differentiated in a differentiator 32, the output of this differentiator or rate of error is designated ψ' , being also applied to the calculator 31. The correction signals from this calculator 31 are applied to jacks 33 controlling the deflector flaps 10. Apparatus that will allow azimuth control is well known in the art and one such means for azimuth control can be found discussed in Patent No. 3,101,919, issued on August 27, 1963, to Pierre J. Madon and entitled "Stabilized Captive Flying Platform Unit."

The captive flying platform unit operates as follows: At rest, the flying platform rests on the articulated rigid frame 13, its three pins 11 being respectively housed in the corresponding cups 17. The metal connecting cables 21 are fully wound on the pulleys, such as 24, of the winch 25 together with the electric conductor lead 26.

The motor 6 is started up while the flying platform is held on the articulated rigid frame 13 at the fingers 11

in the cups 17. The starting torque of the motor 6 is thus transmitted to the articulated rigid frame, and the cardan joint 20 prevents any rotation of the articulated assembly about the vertical axis.

As soon as the motor 6 has reached its working speed, the metal cables 21 are unwound by operating the winch 24, either by hand or by a suitable motor (not shown). The flying platform rises by virtue only of the excess of thrust from air-screw 1 overcoming the weight of the flying platform unit, with the anchoring cables unwound. The winch 24 is stopped when the flying platform has reached its working altitude.

The order of operations is reversed to bring the platform back to the ground.

In order that the present captive flying platform unit may be useful in practice, it is necessary that it be statically and dynamically stable, irrespective of external forces such as the wind which may act upon it.

Under the action of a constant wind V_0 (see FIG. 4), the state of equilibrium of the platform is such that the displacement of the point O with respect to the vertical from the base on the ground is with the wind, the angle of rotation from the horizontal θ of the platform being such that the latter presents its intake face to the wind.

Static stability arises from the fact that if the platform moves from this position of equilibrium, the forces which are applied to it have a tendency to bring it back to its initial position.

The outer forces applied to the device are:

The weight applied at the center of gravity G, viz. mg ;
The traction applied along the axis of the platform, viz. T;
The aerodynamic force F_a applied at R.

The traction T being substantially higher than the weight, all three cables are taut (F_1, F_2, F_3). These tensions are transmitted to the springs of the base on the ground.

Forces F_1, F_2 and F_3 being different from one another and equally distant from point O have a resultant which does not go through O. Therefore, that resultant produces a moment about point O.

Static Equilibrium

A horizontal displacement of point O ($\theta = \text{constant}$) does not modify any of the forces applied (mg, T, F_a).

The efforts upon the springs are not changed nor are the tensions F_1, F_2, F_3 in the cables. Only the inclination of the latter, i.e., the inclination of the efforts, is modified in such a way that their resultant acting upon the platform tends to bring the latter back to its initial position.

In a rotation $\Delta\theta$, for instance counter-clockwise, the efforts applied (mg, T, F_a) are unchanged; the variation of tensions in the cables (F_1 decreases, F_2 and F_3 increase) is such that the resultant of the three forces produces a torque which tends to cancel $\Delta\theta$.

Dynamic Equilibrium

Any increase of the transverse velocity of the platform will make the aerodynamic force F_a smaller; in other words, the platform is submitted to an effort which is directed opposite the variation of velocity which produced said force.

A counter-clockwise velocity of rotation θ' about point O renders aerodynamic force F_a smaller and produces a moment on the platform, said moment acting in the opposite direction to said velocity of rotation. The efforts provided by dampers (shock-absorbers) on the ground tend to reduce the velocity of rotation; the equilibrium is therefore dynamically stable.

To sum up, the platform according to the invention is positively stable, both statically and dynamically, and its stability is due to metal cables 21 and to the device comprising springs and dampers (shock-absorbers) on the ground.

By virtue of the command controls, of which the dia-

gram is shown in FIG. 5, the flying platform maintains a fixed orientation in azimuth.

It should be understood that the present invention has only been described and illustrated by way of explanation and not in any limitative sense, and that modifications of detail may be made therein without thereby departing from its scope. Thus, it is possible:

To drive the air-screw by an independent unit, internal combustion engine, prop-jet engine, turbine, etc., the supply for the unit being independent of the ground;

The useful load, television camera, radar, aerial, etc., can be installed in any desired manner on the flying platform, either above the fairing or below, on the sole condition that it is symmetrically arranged with respect to the axis of the air-screw;

The aerodynamic lift means may be constituted by a plurality of fairing-enclosed air-screws, the flaps for compensating the couple acting on the fairing being dispensed with in the case of an even number of air-screws, one-half of these air-screws rotating in the opposite direction to that of the other half.

Other lifting means may be envisaged, in particular a turbo-jet unit replacing both the fairing-enclosed air-screw and its driving motor.

I claim:

1. A captive flying platform unit, of which the flying platform is aerodynamically placed and held in the air comprising
 - a flying platform including
 - aerodynamic lifting means developing a vertical thrust comprising
 - at least one vertical-shaft air-screw, surrounded by a fairing,
 - a central member coaxial with said air-screw and rigidly connected to said fairing,
 - three radial arms of equal length, each rigidly attached by one of its extremities to the upper part of said central member and spaced angularly apart by 120° in a plane perpendicular to the longitudinal axis of said central member,
 - an electric motor having a supply cable connection to the ground and adapted to drive said fairing-enclosed air-screw, with its stator rigidly connected to said fairing,
 - at least one deflector flap articulated on a portion of said flying platform rigidly connected to said fairing whereby the aerodynamic couple created on said fairing by the rotation of said air-screw may be compensated, each said deflector flap being controlled by a device operating from indications of a course station for setting said flying platform in azimuth;
 - a ground station including
 - a fixed base,
 - a rigid frame having coplanar radial arms of equal length spaced angularly apart by 120° and articulated about a point on said base by means of a cardan joint,
 - a spring and shock absorber located between each of said arms of said articulated rigid frame and said base;
 - and a group of at least three parallel cables of equal length and not located in the same plane coupling the said platform to said rigid frame by connections of a cable between each of said radial arms of said platform to one of said radial arms of said rigid frame;
 - and means for simultaneously varying the lengths of said cables;
 - each of the extremities of said arms on said rigid frame being provided with a pulley, one of said pulleys receiving one of said cables from said flying platform and the other leading the corresponding one of said cables out of the center of said frame.
 2. A captive flying platform unit, of which the flying

platform is aerodynamically placed and held in the air comprising

a flying platform including

aerodynamic lifting means developing a vertical thrust comprising

at least one vertical-shaft air-screw, surrounded by a fairing,

at least one deflector flap articulated on a portion of said flying platform rigidly connected to said fairing whereby the aerodynamic couple created on said fairing by the rotation of said air-screw may be compensated, each said deflector flap being controlled by a device operating from indications of a course station for setting said flying platform in azimuth;

a ground station including

a fixed base,

a rigid frame articulated about a point on said base

and a group of at least three parallel cables of equal length and not located in the same plane coupling the said platform and the said rigid frame and means for simultaneously varying the lengths of said cables.

3. A captive flying platform unit, of which the flying platform is aerodynamically placed and held in the air comprising

a flying platform including

aerodynamic lifting means developing a vertical thrust comprising

at least one vertical-shaft air-screw, surrounded by a fairing,

a central member coaxial with said air-screw and rigidly connected to said fairing,

a ground station including

a fixed base,

a rigid frame articulated about a point on said base

and a group of at least three parallel cables of equal length and not located in the same plane coupling the said platform and the said rigid frame and means for simultaneously varying the lengths of said cables.

4. A captive flying platform unit as claimed in claim 3, in which said flying platform includes three radial arms of equal length, each attached by one of its extremities to the upper part of said central member and spaced angularly apart by 120°, said arms being rigidly fixed in a plane perpendicular to the longitudinal axis of said central member and each of the other extremities of said arms being attached to a different one of said cables.

5. A captive flying platform unit as claimed in claim 3, in which said rigid frame includes, three coplaner radial arms of equal length spaced angularly apart by 120°, each of the extremities of said arms being provided with a pulley, one of said pulleys receiving one cable coming from said flying platform and the other leading the corresponding said one cable out from the centre of said frame.

6. A captive flying platform unit as claimed in claim 3, in which said rigid frame is articulated on said base by means of a cardan joint.

7. A captive flying platform unit as claimed in claim 3, in which said ground station includes a plurality of springs and shock-absorbers located between each of said arms of said articulated rigid frame and said base.

8. A captive flying platform unit as claimed in claim 5, in which said ground station includes a winch having its axis parallel to the plane passing through the free extremity of each of the three arms of said articulated rigid frame and onto which are wound said three metal cables after having passed over said pulleys on said arms, said winch being secured to said base.

9. A captive flying platform unit as claimed in claim 5, in which the lower edge of the fairing of said flying platform comprises three pins adapted to be received in three corresponding cups mounted one on each of said arms of said articulated rigid frame, whereby said platform can be immobilized with respect to said articulated rigid frame when brought back to the ground.

10. A captive flying platform unit as claimed in claim 4, in which said central member comprises, from top to bottom, in position for flight, a strut on which are fixed said three arms to which are attached said metal cables, a stator of an electric motor adapted to drive said fairing-enclosed air-screw, a mechanical member connecting said stator to said strut, said strut being connected to said fairing by a plurality of stays.

11. A captive flying platform unit as claimed in claim 10, in which said central member is extended downwards by a cowling fixed to the fairing of the air-screw by a plurality of radial spokes, said cowling containing a ball race to centre the shaft of said electric motor.

12. A captive flying platform unit as claimed in claim 10, in which said electric motor is supplied from the ground by means of a supply cable wound on said winch.

13. A captive flying platform unit as claimed in claim 4, in which said flying platform includes at least one deflector flap articulated on each of said radial arms, whereby the aerodynamic couple created on said fairing by the rotation of said air-screw may be compensated.

14. A captive flying platform unit as claimed in claim 4, in which said flying platform includes a plurality of stays connecting said central member to said fairing, and at least one deflector flap articulated on each of said stays, whereby the aerodynamic couple created on said fairing by the rotation of said air-screw may be compensated.

15. A captive flying platform unit as claimed in claim 13, in which each said deflector flap is controlled by a device for setting said flying platform in azimuth, said device operating from indications of a course station.

16. A captive flying platform unit as claimed in claim 15, in which said device is mounted on said flying platform and comprises a course station, giving a difference in azimuth, a differentiator for differentiating the said difference, a calculating means receiving the said difference and its differential, and jack receiving signals from said calculating means and operating said flaps in said flying platform.

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