L. MARMONIER.

AUTOMATIC STABILIZER FOR AEROPLANES.

APPLICATION FILED OCT. 19, 1911.

1,050,153. Patented Jan. 14, 1913.

5 SHEETS—SHEET 1.

FIG-1

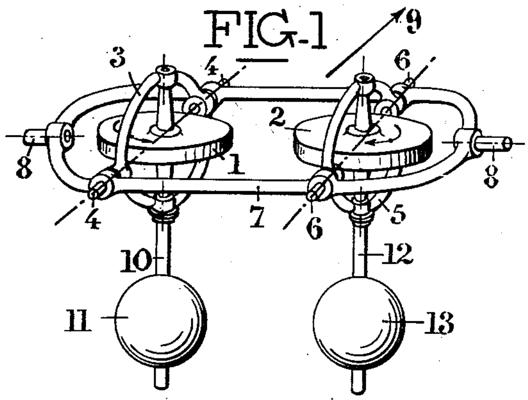


FIG-2

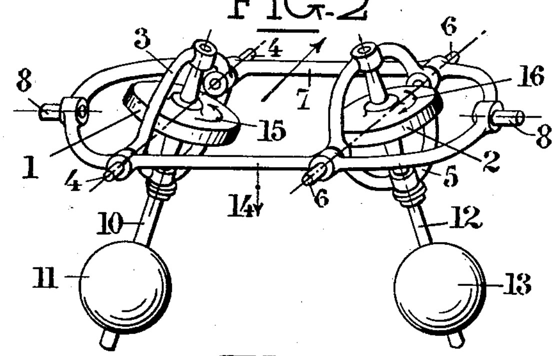
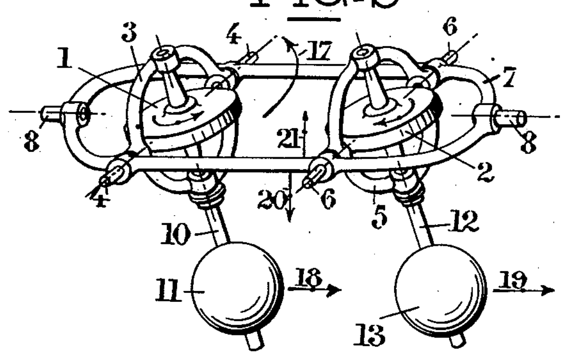


FIG-3



Witnesses:

Jean Germain

Guillaume Pioche

Inventor:

Louis Marmonier

L. MARMONIER.

AUTOMATIC STABILIZER FOR AEROPLANES.

APPLICATION FILED OCT. 19, 1911.

1,050,153. Patented Jan. 14, 1913.

5 SHEETS—SHEET 2.

FIG-4

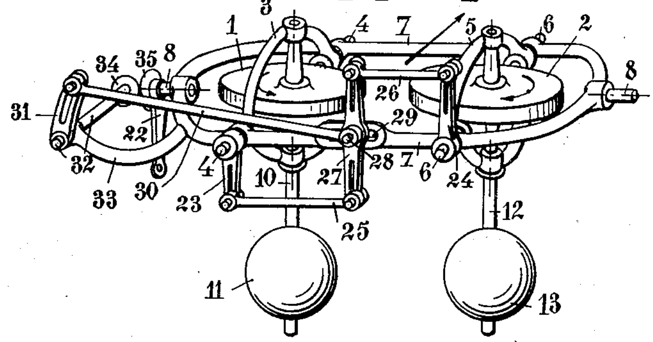


FIG-5

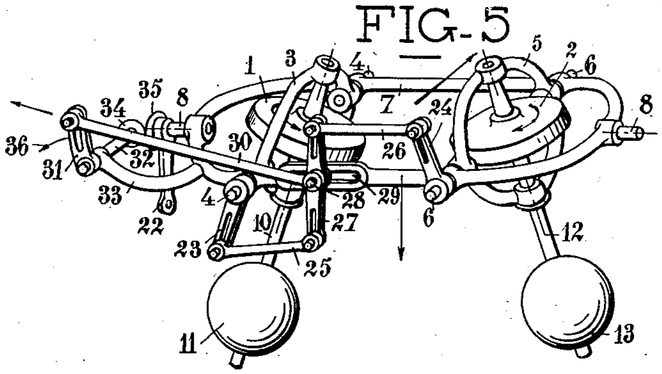
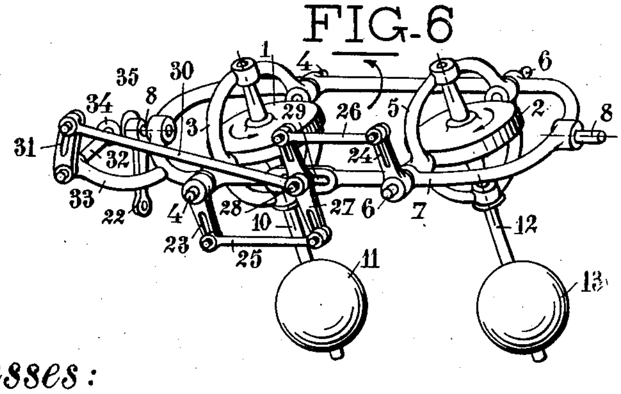


FIG-6



Witnesses:

Jean Germain

Guillaume Pioche

Inventor:

Louis Marmonier

L. MARMONIER.

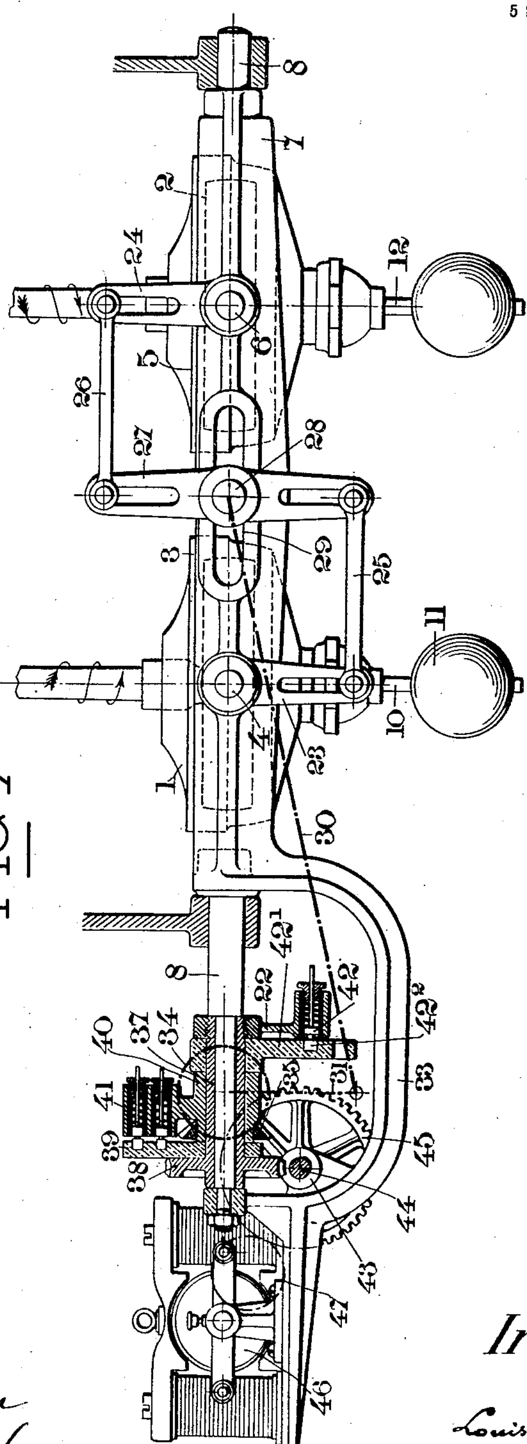
AUTOMATIC STABILIZER FOR AEROPLANES.

APPLICATION FILED OCT. 19, 1911.

1,050,153. Patented Jan. 14, 1913.

5 SHEETS—SHEET 3.

FIG 7



Witnesses:

Jean Germain

Guillaume Pioche

Inventor:

Louis Marmonier

L. MARMONIER.

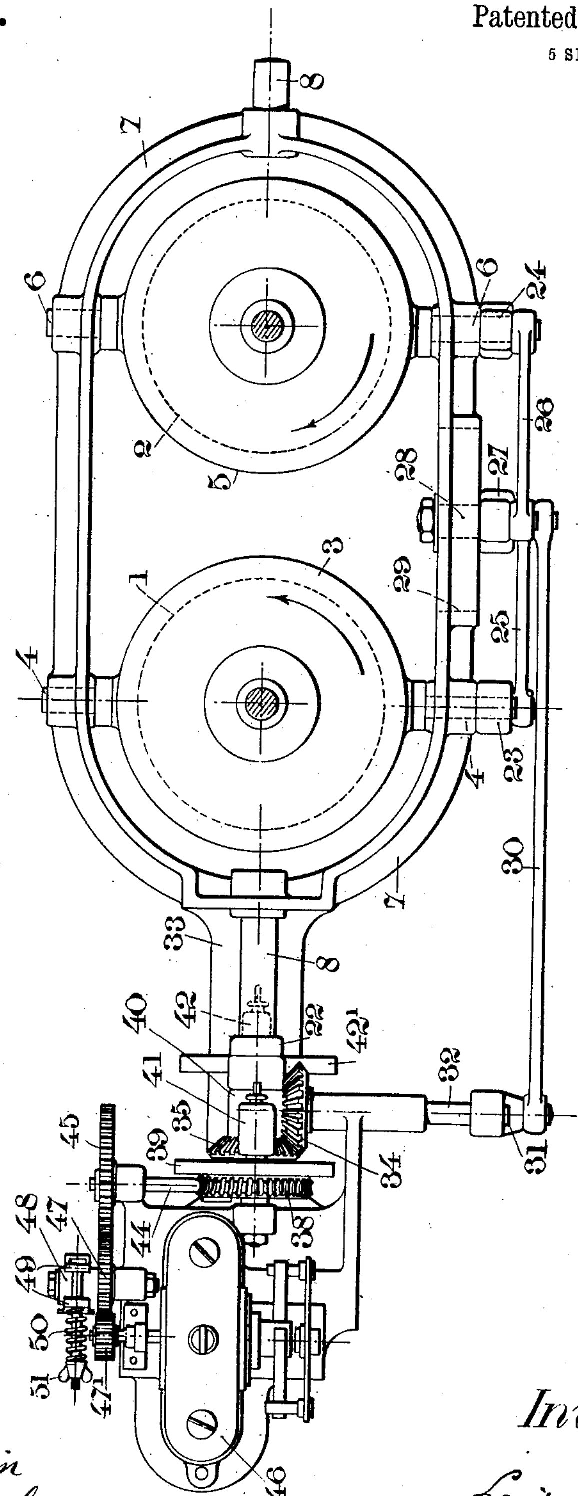
AUTOMATIC STABILIZER FOR AEROPLANES.

APPLICATION FILED OCT. 19, 1911.

1,050,153. Patented Jan. 14, 1913.

5 SHEETS—SHEET 4.

FIG-8



Witnesses:

Jean Germain

Guillaume Pioche

Inventor:

Louis Marmonier

L. MARMONIER.

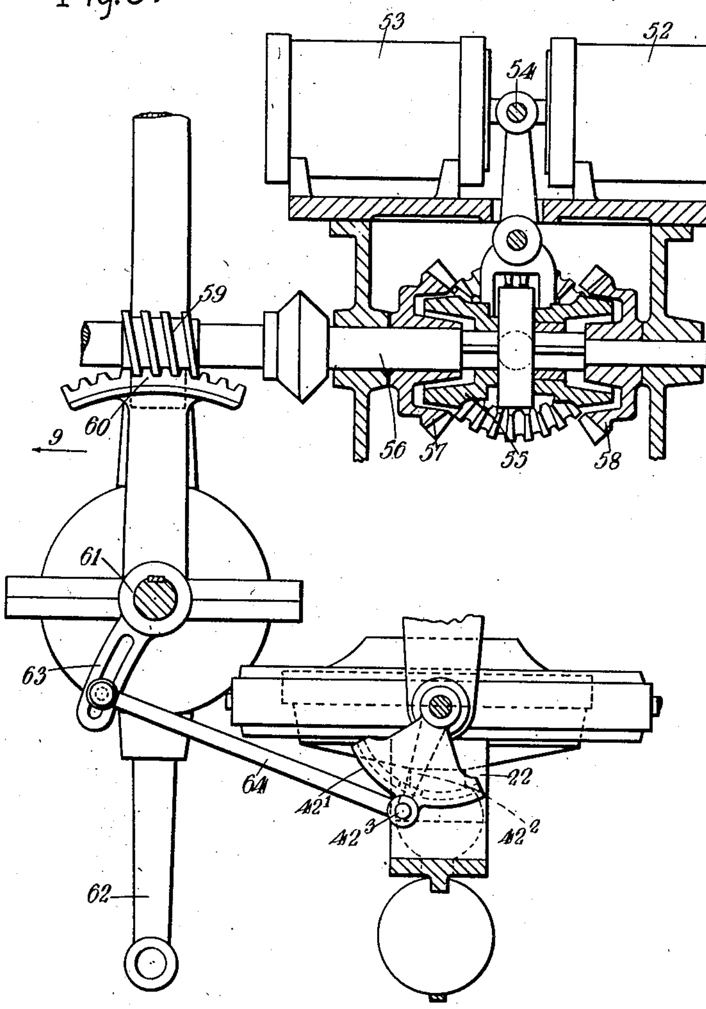
AUTOMATIC STABILIZER FOR AEROPLANES.

APPLICATION FILED OCT. 19, 1911.

1,050,153. Patented Jan. 14, 1913.

5 SHEETS—SHEET 5.

Fig. 9.



Inventor:
Louis Marmonier

per Lawrence Langner
Attorney.

Witnesses:
Gertrude M. Hulst.
S. Kraus

UNITED STATES PATENT OFFICE.

LOUIS MARMONIER, OF LYON, FRANCE.

AUTOMATIC STABILIZER FOR AEROPLANES.

1,050,153. Specification of Letters Patent. **Patented Jan. 14, 1913.**

Application filed October 19, 1911. Serial No. 655,617.

To all whom it may concern:

Be it known that I, LOUIS MARMONIER, a citizen of the French Republic, residing at 37 Rue Servient, Lyon, in France, have invented certain new and useful Improvements in Automatic Stabilizers for Aeroplanes, of which the following is a specification.

This invention has for its object an improved stabilizer for aeroplanes in which the property of the gyroscope to give the aeroplane an invariable position in space, whatever may be the reactions to which it is subjected, is utilized. As this property is only effective up to a certain limit beyond which the external forces become sufficient to displace the gyroscope, it is necessary to provide in addition to this latter a pendulum having a tendency to remain in a vertical plane. This pendulum causes the gyroscope to return to its normal position when it has been displaced provided the pendulum has a sufficient mass to overcome the inertia of the gyroscope itself.

The employment of a pendulum in a stabilizer for aeroplanes renders it necessary to consider the influence of its weight and the action of the forces upon it, in particular the centrifugal force and the *vis viva*. The reaction of the centrifugal force on the pendular mass of the gyroscope may be compensated by the use of two gyroscopes running in opposite directions, and the disturbances due to *vis viva* and inertia may be annihilated by the arrangement which forms the object of the invention and is hereinafter fully described.

In the annexed drawings:—Figures 1, 2 and 3 are diagrammatic views showing in different positions the stabilizer and its gyroscopic pendulums. Figs. 4, 5 and 6 are similar views of the same apparatus provided with a special device for counterbalancing the reactions of inertia. Fig. 7 is an elevation partially broken away of a modification, Fig. 8 is a plan view of the same and Fig. 9 is a side elevation of a submotor hereinafter fully referred to.

The stabilizer is constituted by two gyroscopes 1 and 2 having their axes vertical. The gyroscope 1 rotates within a frame 3 mounted on trunnions 4, 4 and the gyroscope 2 rotates in a similar frame 5 mounted on trunnions 6 6. The trunnions 4 4 and 6 6 are arranged in a frame 7 in such a manner that their axes are parallel with each other and perpendicular to the trunnions 8 8, around which the frame 7 is capable of oscillation. The trunnions 8 8 are supported in bearings fixed to the aeroplane by any suitable means and their axis is perpendicular to the direction of the aeroplane which is indicated by the arrow 9. The frame 3 has threaded therein a rod 10 along which may slide a counterweight or pendulum 11. The frame 5 is provided with a similar rod 12 having a pendulum 13. Both pendulums 11 and 13 are of the same weight and dimensions.

Owing to the disposition of the two gyroscopic pendulums in the frames 3 and 5, any longitudinal movement of one gyroscope causes the displacement of the other, while both are free in their transverse displacements.

In order to obtain the stabilization of aeroplanes it is necessary that the gyroscopes rotate in opposite directions and their speed and weight be equal. The position of the pendulums 11 and 12 on their respective rods must be similar.

The device which has just been described possesses great rigidity in the longitudinal direction and the frame 7 has always a tendency to remain horizontal owing to gravity and the reaction of both gyroscopes. If for instance, a force 14 (Fig. 2) acts to displace the frame 7 out of its horizontal position and the gyroscopic pendulums 1, 11 and 2, 13 rotate respectively as indicated by the arrows 15 and 16, the pendulums 11 and 13—owing to the reaction of the gyroscopes—go away from each other; if on the other hand the force 14 acts in the opposite direction the pendulums 11 and 13 approach each other. The weight of the pendulums and the gyroscopic reaction of the gyroscopes 1 and 2 tend therefore to balance the force 14 and retain the frame 7 in the horizontal position. When the aeroplane makes a swerve for instance, in the direction of the arrow 17 (Fig. 3) the gyroscopic pendulums receive the action of the centrifugal force which tends to bring them out of the curve, in the direction of the arrows 18 and 19, giving rise in both gyroscopes to a gyroscopic reaction which tends to cause the frame 7 to oscillate in the direction of the arrow 21 while the gyroscopic pendulums 11, 13 have a tendency to oscillate the frame in the opposite direction as indicated by the arrow 20. The forces acting in the direction of arrows 20 and 21 are directly opposite and equal each other so that the equilibrium of the frame 7 is not affected and it therefore remains horizontal whatever may be the intensity of the centrifugal force which in consequence acts only to more or less incline the pendulums 11 and 13.

As to the influence of inertia and *vis viva* they act at the starting of the aeroplane or when its speed varies in flight, and they cause the frame 7 to oscillate as if it were acted upon by a force such as 14, (Fig. 2) or a force in the opposite direction. At the same time the pendulums 11 and 13 approach or separate from each other according to the rotation of the gyroscopes and the direction of the force acting on the frame. This property may be employed for compensating for the influence of inertia or *vis viva* by means of the following arrangement. One of the trunnions 8 of the frame 7 bears a loose lever 22 (Figs. 4, 5 and 6) connected to the frame 7 by a special arrangement of pivoted connections which compensate for the displacements of said frame by inertia or *vis viva*. The trunnions 4 and 6 of the frames 3 and 5 carry levers 23 and 24 parallel to the rods 10 and 12 and respectively upward and downward. These levers are connected by rods 25 and 26 to a lever 27 the trunnion 28 of which may be displaced in a slot 29 of the frame 7. This trunnion 28 is connected by a rod 30 to a quadrant 31 fixed to a short shaft 32 supported by a projection 33 of the frame 7. The shaft 32 has, at its other end, a bevel pinion 34 which meshes with a pinion 35 on the lever 22. When the gyroscopic pendulums are displaced, for instance as indicated in Fig. 5, the levers 23 and 24 are also displaced and draw in the same direction the balance lever 27 the trunnion of which itself moves along the slot 29. This displacement is transmitted by the rod 30 to the quadrant 31 which causes the shaft 32 to rotate in the direction indicated by the arrow 36 (Fig. 5). This movement combined with the oscillation of the projection 33 causes the pinion 34 to take an epicycloidal movement around the pinion 35 which remains motionless, as well as the lever 22. It is obvious that this condition may be obtained only when the above mentioned parts are exactly regulated which however is easy to insure owing to the sliding movements of the levers. When the frame 7 comes back to the horizontal position the parts move in the opposite direction in order to keep the lever motionless. The same device also acts when the frame 7 comes back to its normal position only by successive oscillations. If the stabilizer be constructed so as to automatically compensate for the effects of centrifugal force this device would have no action when the pendulums were displaced in the same direction by said force. In this case (Fig. 6) the gyroscopic pendulums are equally displaced and the levers 23 and 24 act in opposite directions on the ends of the balance lever 27 which oscillates about its trunnion 28 without being displaced so that the connecting rod 30 receives no motion. If the pendulums were unequally displaced the gyroscopic reaction on the frame 7 would be compensated by the unequal action of the levers 23 and 24 of the balance lever 27 and causes a sufficient displacement of its trunnion 28 to operate the pinion 34.

It is to be noted that when a gyroscopic pendulum having a Cardan suspension receives the action of disturbing forces it first offers resistance to any displacement; afterward as the gyroscopic force is annihilated it rapidly inclines itself in a direction perpendicular to the disturbing force, while the frame which is at first under the influence of the gyroscopic inertia modifies its position more slowly and thereafter is displaced to a degree dependent upon the mass of the gyroscopic pendulum. A similar action takes place when the gyroscopic pendulum comes back to its initial position under the influence of gravity, but the two movements produced by gravity and the gyroscopic reaction are never synchronous. It is thus necessary to use a supplementary device capable of correcting the backwardness of one of the movements. Figs. 7 and 8 represent by way of example a stabilizer provided with such a device. At the end of the trunnion 8 is a sleeve 37 which bears a helicoidal gear 38 fixed to a current reverser 39. On the sleeve 37 is a second sleeve 40 receiving its movement from a pinion 35 and having two contacts 41 which coöperate with the current reverser 39. At the other end of the sleeve 37 is arranged the lever 22 whose position must remain invariable whatever the oscillations of the frame 7 may be. The lever 22 is provided with a resilient pin 42 which moves against a quadrant 42′ having electric contacts 42^2 connected to a sub-motor which according to the direction of its rotation controls the stabilizing planes of the aeroplane. This sub-motor operates in accordance with the position that the sector 42′ occupies relatively to the contact 42 of the lever 22. According as the latter bears on the contact piece 42^2 or upon the contact piece 42^3 it sends an electric current into one of the electromagnets 52 or 53 which attracts an armature 54 which controls a drum 55 keyed upon a shaft 56 which also carries two pinions 57 and 58. These pinions which are loosely mounted on the shaft 56 form clutch cones at each end of the drum 55; they rotate with a continuous movement but in opposite directions so that when the drum is clutched to one or other of these pinions by the effect of the induction of one of the magnets, the rotation of the shaft 56 takes place in one direction or the other. This shaft which carries an endless screw 59 causes the rotation of a toothed sector 60, the shaft 61 of which controls in the direction in which the aeroplane runs, indicated by the arrow 9, the stabilizing lever 62. At the same time an arm 63 acts through a rod 64 on the sector 42′ to return it to its initial position relatively to the immovable lever 22. The helicoidal wheel 38 gears with a screw 43 on the shaft 44 having at its other end a pinion 45 which receives its motion from an electromotor 46 through gear wheels 47 and 47′. The shaft of the wheel 47 has a sleeve 48 on which are two brake blocks 49 controlled by a spring 50 and a screw-nut 51. The electromotor 46 runs in either direction according to the position of the contacts 41 against the current reverser 39.

The device which has just been described is supported by the projection 33 of the frame 7 and consequently receives the same oscillations as this latter. At the normal position when the frame 7 is horizontal the lever 22 occupies a suitable position. If the equilibrium of the aeroplane is destroyed the gyroscopic pendulums are displaced and act upon the rod 30; then the contacts 41 move against the quadrant 39 of the current reservoir and cause the electromotor 46 to rotate in one or the other direction at a speed which may be controlled by the braking device 49. The running of the motor also causes the sleeve 37 to rotate and consequently to displace the current reservoir 39 and the lever 22. The stabilizing device thus receives two independent movements, first that of the contacts 41 which are controlled by the displacements of the gyroscopic pendulums, and secondly that of the lever 22 the speed of which may be regulated by that of the electromotor 46. The combination of these two movements has the effect of correcting the failure of synchronous deviations between the gyroscopic pendulums and the frame 7, and thus cause the lever 22 to remain motionless in space, the electromotor beginning to run slowly and progressively faster and faster so as to react on said lever 22 when the oscillations of the frame 7 have a tendency to displace it.

What I claim as my invention and desire to secure by Letters Patent of the United States is:—

1. In an automatic stabilizer for aeroplanes the combination of two gyroscopic pendulums running in opposite directions, frames supporting said gyroscopic pendulums pivoted into another frame and having trunnions which project at one end out of said second frame, levers on each trunnion connected by rods to a balance lever the axis of which is movable in a slot in said second frame, a projection in said frame bearing a short shaft, a quadrant at one end of the shaft and a bevel pinion at its other end, a rod connecting said quadrant to the trunnion of the balance lever, a trunnion at each end of the second frame, a sleeve on one of said trunnions having fixed thereto a lever which remains motionless in space, and a pinion keyed on said lever and gearing with the pinion on the said short shaft, substantially as described.

2. In an automatic stabilizer for aeroplanes the combination of two gyroscopic pendulums running in opposite directions, frames supporting said gyroscopic pendulums pivoted into another frame and having trunnions which project at one end out of said second frame, levers on each trunnion connected by rods to a balance lever the axis of which is movable in a slide of said second frame, a projection in said frame bearing a short shaft, a quadrant at one end of the shaft and a bevel pinion at its other end, a rod connecting said quadrant to the trunnion of the balance lever, a trunnion at each end of the second frame, a sleeve on one of said trunnions having fixed thereto a lever which remains motionless in space, a pinion keyed on said lever and gearing with the pinion on the short shaft and an electric device to correct the failure of synchronous deviations between the gyroscopic pendulums and the second frame, comprising an electromotor and means to cause said electromotor to run at first slowly and progressively faster and faster when the oscillations of the second frame have a tendency to displace the motionless lever, substantially as described.

In witness whereof I have signed this specification in the presence of two witnesses.

LOUIS MARMONIER.

Witnesses:

JEAN GERMAIN,

GUILLAUME PIOCHE.