

L. A. HAYOT.
 AUTOMATIC STABILIZING APPARATUS FOR AEROPLANES.
 APPLICATION FILED AUG. 13, 1912.

1,154,396.

Patented Sept. 21, 1915.
 2 SHEETS—SHEET 1.

Fig. 1.

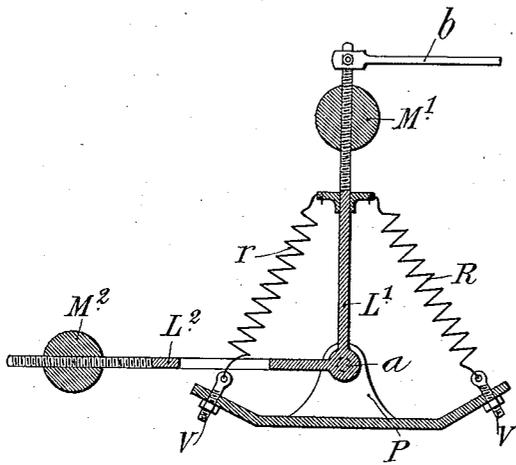


Fig. 2.

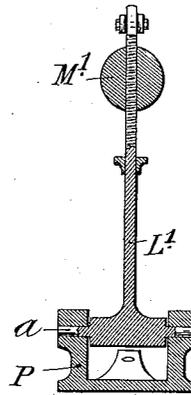
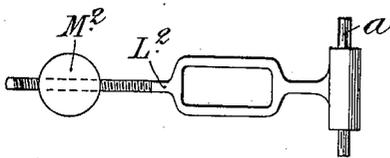


Fig. 3.



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Fig. 4.

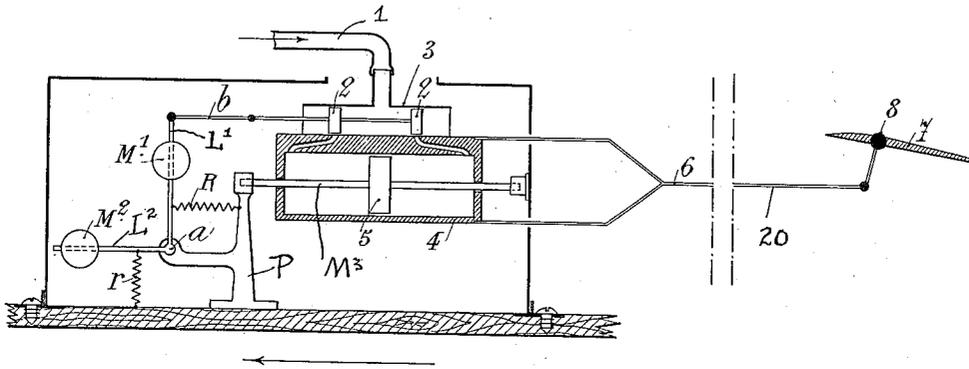
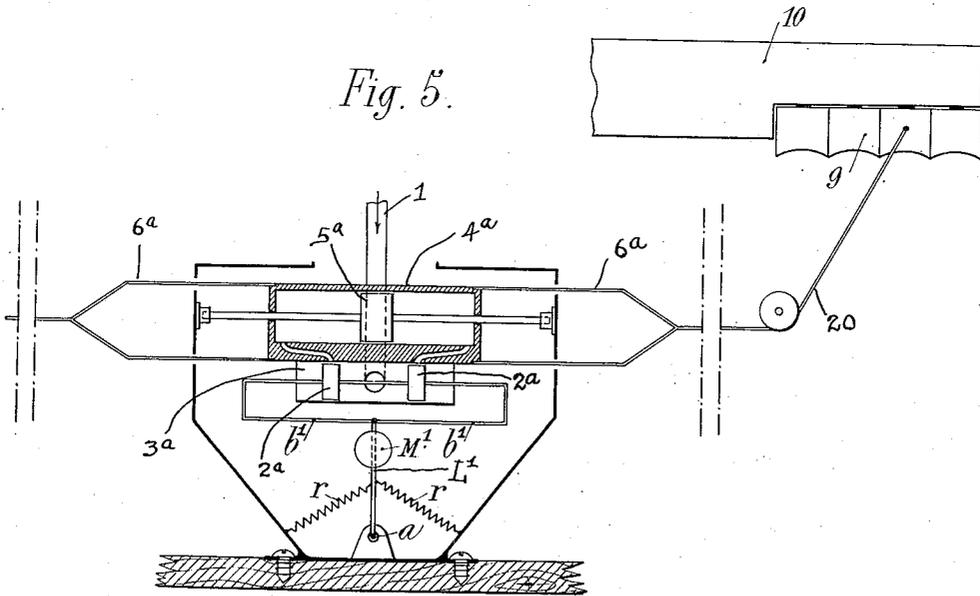


Fig. 5.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC STABILIZING APPARATUS FOR AEROPLANES.

1,154,396.

Specification of Letters Patent.

Patented Sept. 21, 1915.

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To all whom it may concern:

Be it known that I, LOUIS ADOLPHE HAYOT, citizen of the Republic of France, residing at Beauvais, Oise, France, have invented certain new and useful Improvements in Automatic Stabilizing Apparatus for Aeroplanes, of which the following is a specification.

When an aeroplane is subjected to the influence of an atmospheric or other disturbance it is acted upon in the most general case: 1, by a force applied to its center of gravity which changes its translation movement; 2, by a couple of forces whereby it is caused to turn on an axis passing through its center of gravity. In the case of existing aeroplanes these actions are combatted by the pilot by means of the movable devices of the aeroplane, such as an elevating rudder, a steering rudder and auxiliary planes or warping surfaces. The power required for operating these devices may be supplied by an auxiliary motor similar to that used in marine torpedoes. Compressed air supplied by a small compressor driven by the motor is delivered into a reservoir which contains a reserve of power in case of stoppage of the motor and from which reservoir the compressed air is distributed by a slide valve to the cylinder of the auxiliary motor. This slide valve may be operated automatically by any suitable mechanism.

Now the present invention has for its object to provide an improved stabilizing apparatus for aeroplanes which comprises mechanism operating in that manner.

The improved automatic stabilizing apparatus is based substantially on the utilization of the inertia forces due to the linear and angular accelerations to which the aeroplane is subjected by the disturbing force and couple of forces.

The improved apparatus comprises substantially a lever having a great moment of inertia, which lever may be straight or bent adapted to oscillate in unstable equilibrium on an axis fixed to the aeroplane. This lever has a constant tendency to resume its initial position of equilibrium due to the action of suitably adjusted springs. The stabilizer in oscillating on its axis moves with it the distributing slide valve of an auxiliary compressed air motor which actuates the movable devices of the aeroplane such as the

rudders, auxiliary planes or warping surfaces.

The invention is illustratively exemplified in the accompanying drawings, wherein—

Figure 1 is a longitudinal sectional view of my improved apparatus, as constructed for obtaining longitudinal stability of an aeroplane; Fig. 2 is a cross sectional view thereof; Fig. 3 is a plan view of a weighted arm, L^2 , forming part of my device. Fig. 4 is a schematic representation in vertical section, parallel to the axis of the aeroplane, of my device as installed for obtaining longitudinal stability; and Fig. 5 is a schematic view of showing in section my invention as applied to an aeroplane for obtaining transverse stabilization thereof.

As shown in Figs. 1 to 4, $L^1 L^2$ is a bell crank lever carrying on its arms respectively the weights $M^1 M^2$ whereby these arms are endowed with a great moment of inertia. This lever is adapted to rock in unstable equilibrium on an axle a mounted in a bearing P bolted to the aeroplane.

R, r are springs which maintain the bell crank lever in or return it to its initial position of equilibrium when the aeroplane is flying at a uniform speed either in a horizontal direction or in an ascending or descending slightly inclined direction.

The springs may be of different number and arrangement and location from those shown in the drawings their object being in all cases to impart to the whole system a constant tendency to return to initial position in spite of friction, the resistance of the slide valve, etc., and to counterbalance the weight M^2 for the purpose of rendering it independent of the action of its own weight so that it can follow the accelerations acting upon it.

The adjustment of the apparatus is effected by altering the tension of the springs by means of the screws V and moving the weights along the arms of the bell crank lever. In the example shown the arms are screw threaded for a certain length and the weights are screwed thereon with great friction.

b is a connecting rod jointed to one of the arms of the bell crank lever; it serves to actuate the distributing slide valve of the auxiliary motor.

When applied for maintaining longitu-

dinal equilibrium the apparatus is fixed on the aeroplane in such a manner that its axis α is parallel to the principal transverse axis of inertia of the aeroplane or pitching axis, the arm L^1 being vertical. Thus arranged and by reason of the position of its arms and the weights weighting the same, the bell crank lever of the stabilizing apparatus follows all the horizontal and vertical linear accelerations as well as the angular accelerations which the aeroplane experiences in its longitudinal plane of symmetry.

Fig. 4 shows the arrangement of parts when the device is installed to obtain longitudinal stability of the aeroplane. In this figure, 1 denotes a flexible tube connected with a source of compressed air (not shown). Through the tube 1, compressed air is conducted to the cylinder 3 wherein the pistons 2, actuated by the connecting rod b are adapted to slide. The cylinder of the auxiliary motor is designated 4, and is slidable in relation to the piston 5 fixed on the rod M^3 supported by the bearing P. The cylinder 4 carries the projecting frame 6, by means of which the rudder 7, movable about the shaft 8, may be actuated. The movement of the pistons 4 and of the frame 6, correspond precisely, in extent and direction, with the movement of the pistons 2, 2, the latter being directly actuated by the rod b through the movement of the stabilizing device.

For the purpose of maintaining transverse stability the stabilizing apparatus need not follow the vertical accelerations, so that the horizontal arm L^2 of the bell crank lever may be dispensed with, and the device then only includes the straight lever L^1 . It is then fixed on the aeroplane in such a manner that its axis α is parallel to the principal longitudinal axis of inertia or rolling axis of the aeroplane. So arranged it follows all the transverse linear accelerations of the aeroplane, that is to say, the accelerations that are at right angles to its longitudinal symmetry plane as well as the angular accelerations about the rolling axis.

The arrangement for maintaining transverse stability is shown in Fig. 5, wherein the shaft extends longitudinally of the longitudinal axis of the aeroplane. The lever L^1 is connected to a frame b' which serves to actuate the pistons 2^a movable in the cylinder 3^a secured to the cylinder 4^a of the auxiliary motor. The cylinder 4^a is movable relatively to the piston 5^a therein. Projecting from each end of the motor cylinder 4^a is an actuating frame 6^a which, through a flexible connection 20—operates the warping surfaces 9 of the planes 10. In Fig. 5 only one plane 10 has been shown, but it will be understood that in practice two such planes, with attached warping surfaces, are employed.

In the form designed for transverse stability the improved apparatus may also be employed for securing stability of direction in which case its axis of oscillation is arranged at right angles to the plane formed by the rolling and pitching axes of the aeroplane.

In use, longitudinal stability, transverse stability and, if required, also stability of direction, are secured each independently of the others by a separate stabilizing apparatus and a separate auxiliary motor. The cylinders of the auxiliary motors may however be fed from a common compressed air reservoir.

From the foregoing description of the stabilizing apparatus and their arrangement on the aeroplane it will be readily understood that the forces of inertia which set these apparatus in operation act according to their direction, their intensity, and their axes, to cause the stabilizers to turn on their axes and thus move the slide valves of the auxiliary motors in one or the other direction with a greater or smaller speed, stroke and duration. In a word they have the function of operating the rudders and auxiliary planes or warping surfaces of the aeroplane by means of connections provided between those devices and the pistons of the auxiliary motors.

What I claim is:—

1. In stabilizing apparatus for aeroplanes, the combination with stabilizing means, of an auxiliary motor for operating the same, an angular lever having a great amount of inertia pivotally mounted on the aeroplane, an adjustable weight on each arm of the lever and a connection from said lever to said motor whereby the latter operates the stabilizing means in accordance with movements of said lever.

2. In stabilizing apparatus for aeroplanes, the combination with stabilizing means, of an auxiliary motor for operating the same, a fixed pivot carried by the aeroplane, an angular two armed lever having a great amount of inertia and oscillatable about said pivot in unstable equilibrium, an adjustable weight on each arm of the lever and a connection from one arm of said lever to said auxiliary motor whereby the latter operates the stabilizing means in accordance with the oscillations of the lever about its pivot.

3. In stabilizing apparatus for aeroplanes, the combination with stabilizing means, of an auxiliary motor for operating the same, an angular lever having a great amount of inertia pivotally mounted on said aeroplane and oscillatable in unstable equilibrium, an adjustable weight on each arm of the lever, a connection from said lever to said motor whereby the latter operates said stabilizing means in accordance with the oscillations of said lever, and yielding means for automati-

cally restoring said lever to a position of equilibrium.

4. In stabilizing apparatus for aeroplanes, the combination with stabilizing means, of
 5 an auxiliary motor for operating the same, an angular two armed lever having a great amount of inertia pivotally mounted on said
 10 aeroplane and oscillatable in unstable equilibrium, weights adjustably carried on the arms of said lever, and a connection from
 one arm of said lever to said auxiliary motor whereby the latter operates said stabilizing means in accordance with the oscillations of said lever.

15 5. In stabilizing apparatus for aeroplanes, the combination with stabilizing means, of an auxiliary motor for operating the same, an angular two armed lever having a great amount of inertia pivotally mounted on said
 20 aeroplane and oscillatable in unstable equilibrium, weights adjustably carried on the arms of said lever, a connection from one arm of said lever to said auxiliary motor whereby the latter operates said stabilizing
 25 means in accordance with the oscillations of

said lever, and springs connected with said last mentioned arm and adapted to restore said lever to a position of equilibrium.

6. In stabilizing apparatus for maintaining the stability of aeroplanes, the combination with stabilizing means, of an auxiliary
 30 motor for operating the same, said motor having ports for the admission of operating fluid thereto, valves slidable over said ports, a two armed lever pivotal about a fixed axis,
 35 a movable weight on each arm of said lever, springs acting against opposite sides of one arm of said lever, and tending to hold the latter in equilibrium, and means directly
 40 connecting the last mentioned arm of said lever with said valves for operating the latter to govern the admission of operating fluid to the cylinder of said auxiliary motor.

In testimony whereof I have affixed my signature in presence of two witnesses.

LOUIS ADOLPHE HAYOT.

Witnesses:

LOUIS FAUTRAT,
 H. C. COXE.