Aug. 21, 1923. 1,465,500

A. T. VANCE

AUTOMATIC STABILIZER FOR AIRCRAFT AND THE LIKE

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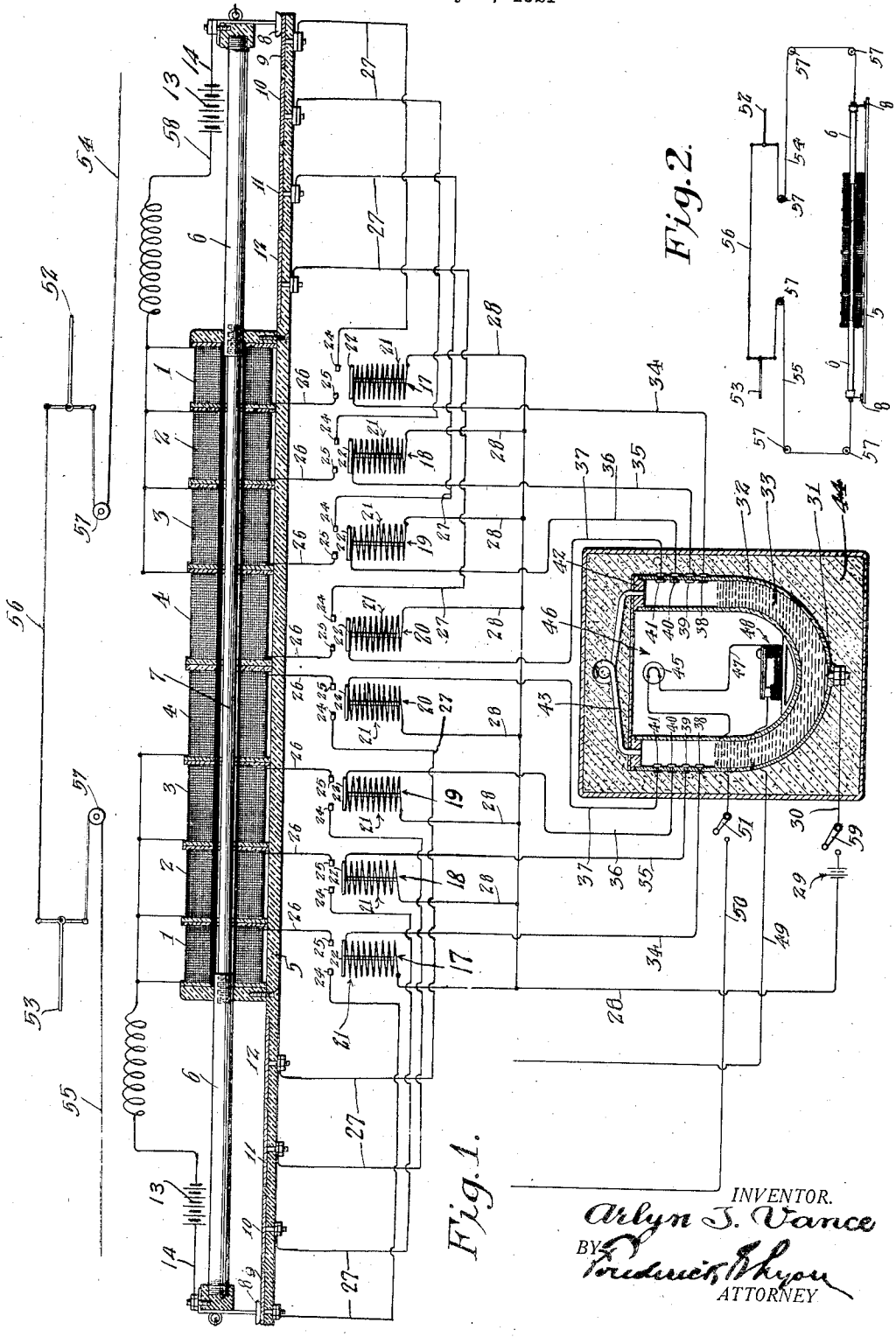


Fig. 1.

Fig. 2.

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AUTOMATIC STABILIZER FOR AIRCRAFT AND THE LIKE.

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To all whom it may concern:

Be it known that I, ARLYN T. VANCE, a citizen of the United States, and a resident of Los Angeles, in the county of Los Angeles and State of California, have invented certain new and useful Automatic Stabilizers for Aircraft and the like, of which the following is a specification.

This invention pertains to devices capable of actuating the tilting planes or surfaces of aircraft to cause the craft to recover from fore and aft and lateral tilting relative to the horizontal plane of flight.

An object of the invention is to make provision for a sensitive control so that comparatively small degrees of tilting of the aircraft will be quickly corrected.

Another object is to provide for actuating the tilting planes by electromagnetic force.

Another object is to provide for closing the main electric circuits through the agency of a liquid column, which tends to seek a horizontal plane, and contacts which move up and down relative to the liquid level according as the tilt of the aircraft is up or down.

Another object is to provide for a lag in the self-adjusting of the liquid level to a horizontal plane upon slight but quick tilting movements of the aircraft.

Another object is to provide for uniform operation of the device at varying atmospheric temperatures.

The accompanying drawing consisting of Figs. 1 and 2 illustrates the invention, the same being vertical cross-sections and more or less diagrammatic in character, showing also the electrical connections.

There are provided two series of solenoids 1, 2, 3, 4, each series preferably composed of solenoids of different magnetic strengths arranged in regular order from weaker to stronger. In this instance the weaker solenoids are at the outer ends of the series and the stronger solenoids at the inner ends. The two series are placed in axial alinement and are mounted upon an electric insulating base 5.

Armatures 6 are provided for the respective series of solenoids and are connected with each other by a non-magnetic rod 7, so that when either of the armatures is attracted by energization of the adjacent solenoid, the other armature will be moved in the same direction.

The outer ends of the armatures are provided with electric contacts 8 adapted to respectively engage series of contacts 9, 10, 11, 12, which are mounted upon the base 5. The relation between the armatures 6 and contacts 8 is such that when the inner ends of the armatures are inserted slightly in the solenoids 1, 2, 3, 4, respectively, the contacts 8 will engage the outer ends of the contacts 9, 10, 11, 12.

Two series of relays are provided and are indicated in general by the characters 17, 18, 19 and 20, respectively, there being one relay for each of the solenoids 1 to 4, inclusive. It is to be understood that the solenoids and relays may be provided in greater or less number, according to the requirements of the user. The relay coils are indicated at 21 and their armatures at 22, and the armatures 22 engage contacts 24, 25, respectively, when the coils 21 are energized. The contacts 25 in order from right to left on the right side and from left to right on the left side are connected by electric wiring 26 to the respective solenoids 1, 2, 3 and 4. The contacts 24 are connected by electrical wiring 27 to the respective contacts 9, 10, 11, 12. Thus, when any one of the relay armatures 22 is actuated to engage the associated contacts 24, 25, the appropriate one of the solenoids 1 to 4, inclusive, will be energized to thereby attract the adjacent armature 6.

In order to operate the relays 17 to 20 consecutively, the following provision is made: The coils 21 are all connected at one end by electric wiring 28 to one pole of a source 29 of electric current, the other pole of said source being connected by electric wiring 30 to a contact 31 projecting into the lower end of a vessel 32 which is partly filled with a liquid 33 such, for example, as mercury. This liquid body 33 is normally in electric engagement with the contact 31. The other ends of the coils 21 of the respective relays 17, 18, 19 and 20 of both series are connected by electric wiring 34, 35, 36 and 37 to contacts 38, 39, 40, 41, respectively, arranged one above the other, in the order given, in the vessel 32, the level of the liquid

33 being below the lowermost contact 38, when the vessel 32 is positioned with its upper ends in a horizontal plane as shown in the drawing. The electric wiring 30 is provided with a switch 59.

The vessel 32 is in the form of a U-shaped tube and the upper ends thereof are closed by plugs 42 through which pass the opposite ends of a tube 43, the opposite ends of the vessel 32 thus communicating with one another in order that displacement of air can take place from either end of the vessel 32, when the vessel is tipped so as to contact the space above the liquid at either end of the vessel. As the vessel 32 is tilted to one side or the other, the liquid 33 will contact successively with the contacts 38, 39, 40, 41 on that side of the vessel which is being lowered relative to the other side, thus successively completing the electric circuits through the relays 17, 18, 19 and 20 of the appropriate series thereof.

The vessel 32 is preferably enclosed in heat insulating packing 44 so as to aid in maintaining the vessel and its contents at a uniform temperature. However, means are provided for furnishing heat to the vessel and its contents, when this is necessary to maintain the temperature at the desired uniformity. For this purpose, an electric heater 45, which may be in the form of an incandescent lamp as shown in the drawings, is mounted within a space 46 provided between the legs of the U-shape vessel 32. One terminal of the heater 45 is connected by electric wiring 47 to one of the terminals of a thermostat 48 mounted within the space 46 beneath the heater 45. The other terminals of the thermostat 48 and heater 45 are connected by electric wiring 49, 50, respectively, to any suitable electric current source, not shown. The electric wiring 50 is provided with a suitable switch 51 which, when closed, permits electric current from the source 14 to flow through the heater 45 if the thermostat is operated by lowering temperature to close the electric circuit in which the heater 45 is included. When the temperature rises to a predetermined level, the thermostat 48 operates to open the circuit in which the heater 45 is included. The solenoids 1 to 4 of each series are connected by electric wiring 58 to a source 13 of electric current and each source in turn is connected by wiring 14 to the contacts 8.

In order to make clear the application of the invention, in actual practice, to a device with which it is designed to function, I have illustrated in the drawing the stabilizing planes or surfaces of an aircraft, said planes being indicated at 52, 53, respectively. These surfaces 52 may be the ailerons, or the elevators of an aircraft which it is desired to maintain in approximately horizontal flight automatically irrespective of the tendency of different air currents to cause lateral and longitudinal tilting of the aircraft with which the automatic stabilizer is associated. In the instance shown, the stabilizing surfaces 52, 53 are connected by suitable connections 54, 55 to the outer ends of the respective armatures 6 and are connected to one another by suitable connections 56. Any required number of pulleys 57 may be provided for changing the direction of pull of the connections 54, 55, and such pulleys may also be provided, when necessary, for the connection 56.

In practice, assuming that the switches 51 and 59 are closed and that the other parts are in the positions shown in the drawing, the aircraft with which the stabilizer is associated will be normally flying in a straight path in a horizontal plane, since the stabilizing surfaces 52, 53 are positioned to produce this result. If variation in the air currents meeting the aircraft produces deflection of the wing surface of the aircraft of that portion of the craft adjacent the surface 52, the vessel 32 fixed to the aircraft will be caused to tilt downwardly to the right, thus bringing the lowermost right-hand contact 38 into engagement with the liquid column 33 and closing the electric circuit through the right-hand relay 17, that thereupon operates to close the electric circuit in which is included the right-hand solenoid 1 to thereby pull the adjacent armature 6 further into said solenoid. The armature advances sufficiently to cause the contact 8 to bridge the gap between the contacts 9, 10 on the right side of the device, thus maintaining the circuit through the solenoid 1 and also preparing the connections between the next adjacent solenoid 2 and the next adjacent relay 18 for subsequent energization of the solenoid 2, if the aircraft continue to tilt downwardly to the right. When the armature 6 is moved into the solenoid 1, it deflects the outer end of the stabilizing surface 52 and elevates the outer end of the stabilizing surface 53, thus, as is well known in the art pertaining to aviation, tending to right the aircraft or overcome the tilt due to inequality of the air currents through which the aircraft is passing. If this righting movement of the stabilizing surfaces 52, 53 is sufficient to bring the aeroplane back into its horizontal plane of flight, the vessel 32 will return to its normal level position of horizontal flight, thus breaking the electric contact between the contact 38 and liquid 33, whereupon the pressure of air against the under surface of the stabilizing plane 52 and upper surface of the plane 53 will cause said planes to assume a position of equilibrium or, in other words, the horizontal positions shown in the drawing. This return of the planes 52, 53 to normal horizontal position pulls the armatures 6 endwise to the posi-

tions shown in the drawing, such positions being those occupied previous to tilting of the aircraft.

If the righting of the aircraft is not accomplished by movement of the right hand armature 6 by the distance that can be effected by the solenoid 1 and if the aircraft continue to tilt, the second right hand contact 39 will descend relative to the liquid 33 until it engages said liquid and completes the circuit through the second right hand relay 18, thus establishing a circuit through the second right hand solenoid 2 to actuate the right-hand armature still further toward the left and thus deflect by a still greater amount the stabilizing surface 52 and elevate the surface 53 by a like amount. As the armature 6 is attracted by the stronger solenoid 2 it moves the contact 8 off of the contact 9, thus cutting out the weaker solenoid 1 and the associated relay 17.

When lower temperatures tend to reduce the volume of the liquid 33 and thus lower the level of the liquid, the thermostat closes the circuit through the heater 45, thus maintaining the relation substantially constant between the contacts 38 and level of the liquid when the vessel 32 is horizontal, to thereby insure that the device will be of uniform sensitiveness at different atmospheric temperatures encountered by the aircraft with which the device is associated.

It is to be understood that the armature 6 need not be directly connected to the planes 52, 53 but that they may be connected thereto through a manual control such, for example, as that disclosed and claimed in my patent for craft with automatic stabilizer No. 1,350,579, issued August 24, 1920, thus to provide for both automatic and manual control.

It is to be noted that, owing to the cross sectional area of the tube 43 being less than that of the tube 32, if the tube 32 be suddenly tilted, due to choppy conditions of the atmosphere tilting the aircraft now up and now down fore and aft or by the beam, the liquid will be caused to lag in assuming the level or state of equilibrium because of the comparatively slow escape of air from the space above the rising end of the liquid body through the tube 43 into the space above the falling end of the liquid body. Thus, if the deviation from normal flight in a horizontal plane be but momentary, the energizing circuit for the relays will not be closed and, consequently, the stabilizing planes will not be moved relative to the wing surfaces of the aircraft.

I claim:

1. In an automatic stabilizer, the combination of a vessel, a liquid partly filling the vessel, electric contacts at different levels in the vessel above the surface of the liquid when the vessel is in normal position, a contact below the surface of the liquid in the vessel when the vessel is in normal position, a series of solenoids of graduated strength, means whereby successive energization of the respective solenoids from weaker to stronger is effected when the vessel is tilted to lower the first contacts into the liquid, and an armature adapted to be attracted successively by the solenoids as they are energized.

2. In an automatic stabilizer, the combination of a vessel, a liquid partly filling the vessel, electric contacts at different levels in the vessel above the surface of the liquid when the vessel is in normal position, a contact below the surface of the liquid in the vessel when the vessel is in normal position, a series of solenoids, a series of relays, electric wiring between the relay coils and the respective first named electric contacts, electric wiring between the second electric contact and the relay coils, electric wiring between one of the contacts of the different relays and the respective solenoids, an armature adapted to be attracted successively by the solenoids as they are energized, an electric contact carried by the armature, a series of electric contacts adapted to be successively engaged by the armature contact as the armature is actuated by energization of the successive solenoids, the armature contact being adapted to bridge the space between each two adjacent last named contacts when the armature reaches the ends of the movements produced by the respective solenoids, electric wiring between the solenoids and the armature contact, and electric wiring between the solenoids and the other relay contacts.

3. In an automatic stabilizer, the combination of a vessel, a liquid partly filling the vessel, electric contacts at different levels in the vessel above the surface of the liquid when the vessel is in normal position, a contact below the surface of the liquid in the vessel when the vessel is in normal position, a series of solenoids, means whereby successive energization of the respective solenoids is effected when the vessel is tilted to lower the first contacts into the liquid, an armature adapted to be attracted successively by the solenoids as they are energized, and means operative by movement of the armature to successively cut in the different solenoids and to thereafter successively cut out said solenoids as the armature advances.

4. In an automatic stabilizer, the combination of a series of solenoids, means whereby successive energization of the respective solenoids is effected by tilting of the craft being controlled, an armature adapted to be attracted successively by the solenoids as they are energized, and means operative by movement of the armature to successively

cut in the different solenoids and to thereafter successively cut out said solenoids as the armature advances.

5. In an automatic stabilizer, the combination of a series of solenoids, an armature adapted to be attracted successively by the solenoids as they are energized, relays for the respective solenoids electrically connected therewith, contacts connected respectively with the relays, an electric contact operative by movement of the armature to engage the first contacts successively and electrically connected with the solenoids, and means whereby successive energization of the respective relays is effected by tilting of the craft being controlled.

Signed at Los Angeles, California, this 21st day of April 1921.

ARLYN T. VANCE.

Witnesses:
GEORGE H. HILE,
L. BELLE WEAVER.