W. W. SWAN.

AUTOMATIC CONTROLLER FOR FLYING MACHINES.

APPLICATION FILED MAY 11, 1914.

**1,150,903.**

Patented Aug. 24, 1915.

2 SHEETS—SHEET 1.

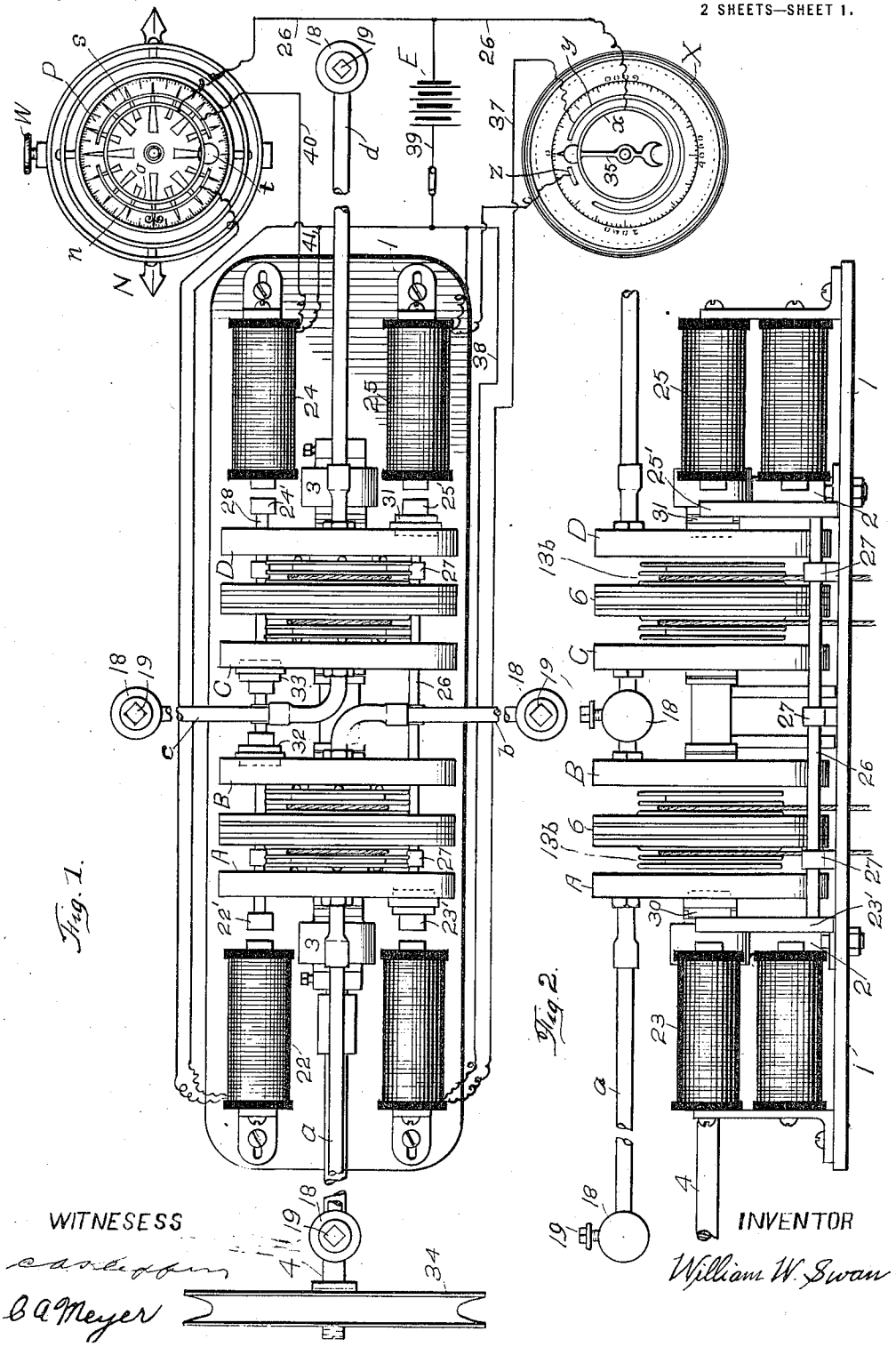



Fig. 1.

Fig. 2.

WITNESSES

C. A. Meyer

INVENTOR

William W. Swan

W. W. SWAN.

AUTOMATIC CONTROLLER FOR FLYING MACHINES.

APPLICATION FILED MAY 11, 1914.

**1,150,903.**

Patented Aug. 24, 1915.

2 SHEETS—SHEET 2.

Fig. 3.

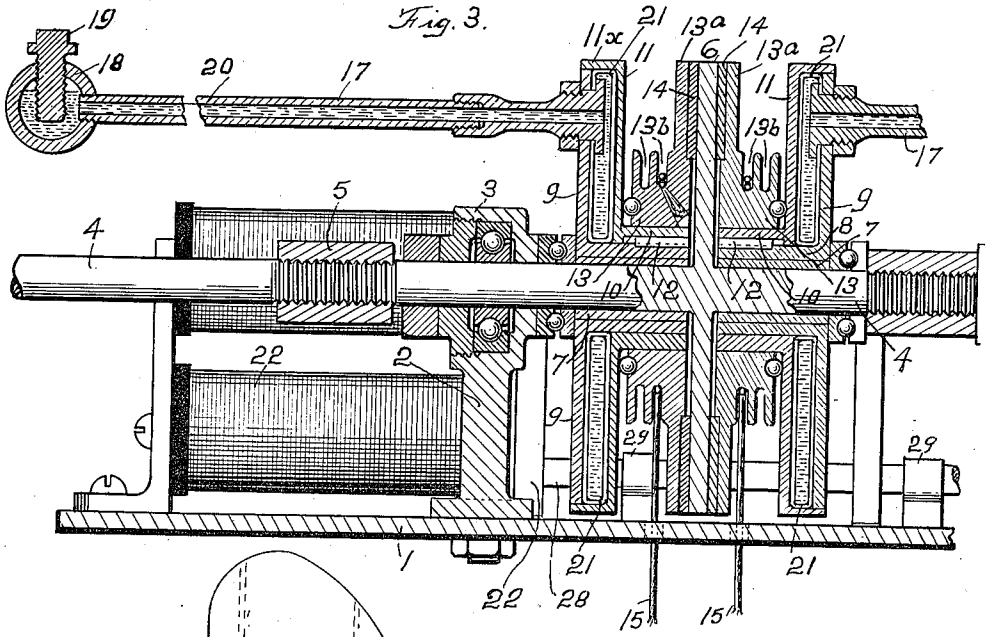
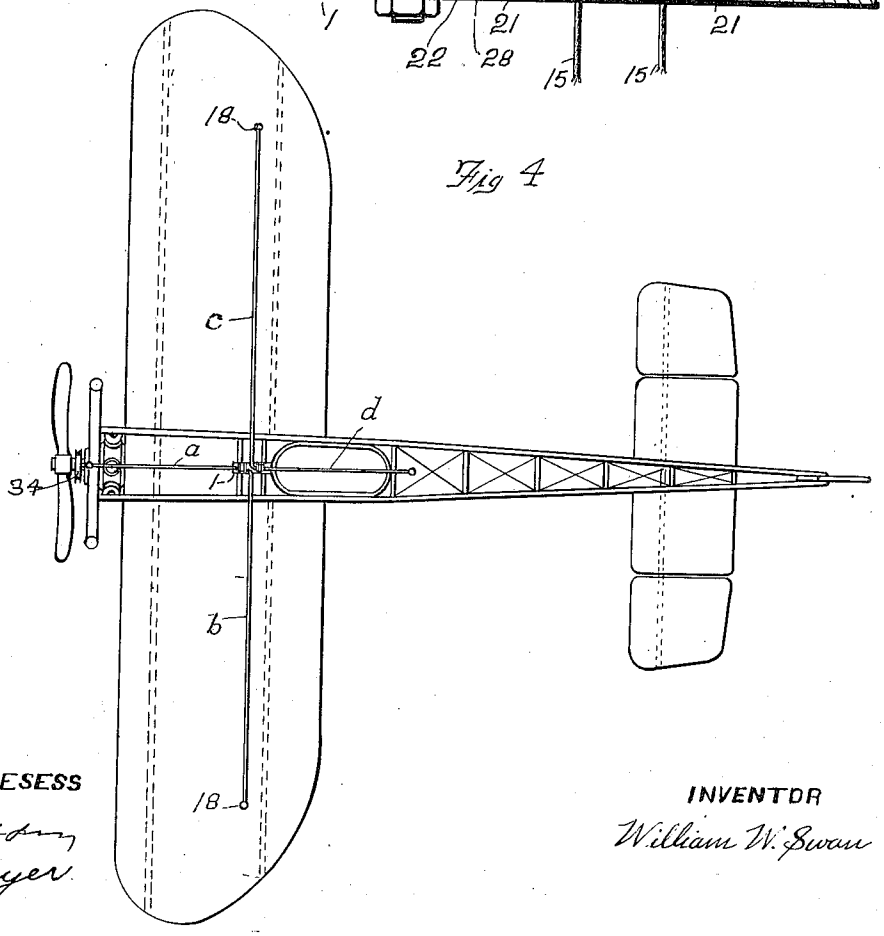



Fig 4




WITNESSES

E. A. Meyer

INVENTOR

William W. Swan

# UNITED STATES PATENT OFFICE.

WILLIAM W. SWAN, OF FRANKFORT, SOUTH DAKOTA.

## AUTOMATIC CONTROLLER FOR FLYING-MACHINES.

1,150,903. Specification of Letters Patent. Patented Aug. 24, 1915.

Application filed May 11, 1914. Serial No. 837,909.

*To all whom it may concern:*

Be it known that I, WILLIAM W. SWAN, a citizen of the United States, and a resident of Frankfort, in the county of Spink and State of South Dakota, have made certain new and useful Improvements in Automatic Controllers for Flying-Machines, of which the following is a specification.

My invention relates to improvements for automatically controlling flying machines, and it consists in the combinations, constructions, and arrangements herein described and claimed.

An object of my invention is to provide means by which the movement of flying machines may be so controlled as to render them stable and less liable to overbalance.

A further object of my invention is to provide a novel stabilizing means in which wing warping, and the movements of steering and balancing planes are accomplished by power transmitted by drums actuated by frictional controlling means.

A further object of my invention is to provide means which may be set to cause the machine to rise to a predetermined height, and to thereafter maintain a course substantially in a horizontal direction at the set altitude.

A further object of my invention is to provide means which may be so set as to cause the flying machine to proceed in a given direction, the direction being controlled automatically.

Other objects and advantages will appear in the following specification, and the novel features of the device will be particularly pointed out in the appended claims.

My invention is illustrated in the accompanying drawings forming part of this application, in which—

Figure 1 is a plan view of the device, Fig. 2 is a side view, Fig. 3 is a vertical sectional view through a portion of the device, and Fig. 4 is a diagrammatic view showing a flying machine with the stabilizing means applied thereto.

In carrying out my invention I provide a base 1, upon which are mounted uprights 2, having at their tops bearings 3, preferably of the anti-friction type as shown in Fig. 3, for a shaft 4. This shaft as will be seen from Fig. 3, is preferably made up of a number of sections joined together by means of unions 5. This is merely for convenience in assembling, and a single shaft may be used instead.

Secured to the shaft are disks 6, which are designed to revolve with the shaft. The shaft is provided with self-lubricating bearing members or bushings, such as that shown at 7, in Fig. 3. Disposed on the outside of the bushings 7, are tubular portions 8, bearing heads 9, these heads being in the form of disks, whose planes are at right angles to the shaft. Disposed exteriorly of the tubular portions 8, are tubular portions 10, having heads 11, provided with flanges $11^x$, which extend over the ends of the heads 9, thereby forming an annular receptacle between the heads 9 and 11. The heads 9 and 11 are prevented from relative rotation by means of a feather key 12, which is disposed in one of the tubular portions such as that shown at 8, the other tubular portion being provided with a groove so as to permit longitudinal motion of the tubular portion 10, with respect to the tubular portion 8.

Disposed exteriorly of the tubular portions 10, are drums 13, which are designed to revolve on the tubular portions 10, and which are provided with radially extending heads $13^a$, faced with frictional linings 14, arranged to engage the central disk 6, as shown in Fig. 3. These drums are provided with grooves $13^b$, arranged to receive flexible cables 15.

Carried by the heads 9, are tubes 17, which bear at their ends receptacles 18, having means such as screw plugs 19 for varying the capacity of the receptacle. These receptacles are partly filled with mercury 20, and communicate with the interior of the space between the heads 9 and 11. This space is provided with an air-tight resilient lining 21 either of rubber or thin corrugated metal, or the like.

Referring now particularly to Figs. 1 and 2, I have shown therein a plurality of magnets, which I have denoted by the reference characters 22, 23, 24 and 25 respectively. These may be either single magnets, or double magnets as shown in Fig. 2. Each magnet is provided with an armature, and the armatures of the oppositely disposed magnets are connected together. Thus in Fig. 2 it will be seen that the armature 23′ of the magnet 23, is connected with the armature 25′ of the magnet 25, by means of a rod 26, which is slidable in bearings 27. The armature 24′ of

the magnet 24 and the armature 22′ of the magnet 22 are connected together by a similar rod 28, slidable in bearings 29.

The portion of the device illustrated in Fig. 3, shows that there are two hydrostatic presses, each provided with a laterally extending tube which serves to supply pressure for moving the drums into frictional contact with the revolving disk 6. In Fig. 1 it will be seen that there are four of these presses, and in order to clearly explain the action, I have designated the presses generally by the reference characters, A, B, C and D, respectively, and their connecting tubes by *a*, *b*, *c* and *d* respectively. It will be noted that the tubes *a* and *d* extend longitudinally of the machine as shown in Fig. 4, while the tubes *b* and *c* extend laterally.

As will be seen from Fig. 2, the armature 23′ of the magnet 23 is connected with a piston 30, which extends partly into the interior of the press A. The armature 25′ of the magnet 25, has a piston 31, which extends into the interior of the press D. In Fig. 1 it will be seen that the rod 28 is provided with two pistons 32 and 33 respectively, the former extending into the press B, and the latter extending into the press C.

The operation of the parts thus far described is as follows: The chambers 18 of the various tubes are designed to inclose a quantity of air sufficient to balance atmospheric pressure, and also to permit contraction and expansion from altitude and temperature without causing excessive normal pressure in the press, and in addition it provides a reservoir of liquid to compensate for wear between the friction surfaces. The shaft 4 is designed to be rotated by any suitable means as by a pulley 34 and suitable connections to the engine of the flying machine (not shown).

The cables 15, are such as are ordinarily used to transmit energy for wing warping and manipulating ailerons and elevating and steering planes. I have not illustrated the connections of these cables, since the stabilizing device may be used on machines of any type, in which the steering planes and ailerons or wing warping devices are suitably connected to it.

When the device is in its normal horizontal position with the shaft 4 revolving, it will be obvious that the pressure which tends to hold the heads $13^a$, of the drums 13, against the friction disks 6, will be alike in each drum and practically zero. If, however, the flying machine should tip to the left thus raising the outer end of the tube *c* Fig. 4, the hydrostatic pressure in the press C would increase simultaneously and in proportion with the elevation of the outer end of *c*, tending to cause a movement of the portion $11^x$, the integral portion 10 tending to slide toward the disk 6, carrying with it the drum 13 and increasing the pressure of the same against the revolving disk 6, thereby causing the revolution of the drum 13, and the corresponding movement of the aileron or wing warping device which will tend to restore the machine to its horizontal position. The pressure at the inner end of the tube *c* decreases gradually to zero as the machine resumes its normal position laterally, and the corresponding drum is rendered inactive. If the machine tips to the right thus elevating the outer end of the tube *b*, a reverse effect is produced in like manner through the press B, and the adjacent drum connected with the same mechanism reversely. Similarly, the presses A and D, with their oppositely fore-and-aft extending tubes *a* and *d*, and their corresponding drums and lines oppositely connected with the vertical steering apparatus control longitudinal stability. Thus, a tip downwardly in front elevates the tube *d* actuating the press D and its corresponding drum which is connected to give the ascending adjustment to the elevating planes. A contrary tip produces an opposite effect upon the same mechanism through the opposing tube *a*, press A, and the corresponding drum and line.

The arrangement by which the device may be set for a predetermined elevation is shown in Fig. 1. This consists of a barometer X, which is provided with a rotatable transparent face having attached to its inner surface concentric conducting members, *x*, *y* and *z*, with their under faces in the same plane. A conducting hand 35, is arranged so that in its movement it may connect the inner conductor *x* with either the conductors *z* or *y* or it may move to an intermediate position between the conductors *z* and *y*.

The further construction of the electrical connections is best explained by a statement of the operation of this automatic barometric regulator. To control the plane of travel automatically, the machine may be steered by hand control to the height desired, when the cover of the barometric switch is turned until the hand 35 comes midway between the conductors *z* and *y*, and the battery E switched on. As long as the hand 35 is between the terminals *z* and *y*, the circuit through the control magnets is open. If from any cause the aeroplane descends below the set altitude, the hand 35 moves until it comes into contact with the conductor *y*. A current is now established from the battery E through 26, *x*, 35, *y*, 37, magnet 23, 38, 39, back to battery. This will cause the attraction of the armature 23′ and will cause the movement of the piston 31 into the press D. The drum operated by the press D will be brought into frictional engagement with the revolving disk 6, and

the elevating plane will be operated to bring the machine back to the set altitude. It will be noted that the movement of the elevating plane is instantaneous, and to a degree commensurate with the full power of the magnet multiplied by the hydrostatic press D. This sudden movement of the elevating plane is automatically graduated and modified as follows: The instant the front of the machine begins to rise responsive to the changed angle of the elevating plane the press A is acted upon by the static pressure in the arm *a*, and this actuates the drum controlled by the press A in opposition to the electro-magnetic actuated drum D, so as to bring the elevating plane back to its normal position, when the tension on each of the drums is balanced. This leaves the machine propelled in a slightly ascending slant with the vertical steering planes in their normal position of flight. The instant the aeroplane has ascended sufficiently to cause the barometer hand carrying the switch to move back and open the circuit of the magnet 23, the drum controlled by the press D instantly looses its tension and becomes inactive and the unopposed tension on the line of the drum controlled by the press A, brings the elevating planes into position to force the machine into horizontal flight, when there is no tension on either of the opposing drum lines. Should the aeroplane from any cause rise above the set altitude, the indicating hand of the barometer moves into contact with the conductor *z*, in which case the action is similar but in the reverse direction from that described.

It is obvious that the barometric switch may be set at the ground to carry the aeroplane to any desired altitude, where it may be maintained automatically. The means by which the lateral direction of the aeroplane is controlled is also shown in Fig. 1. It consists of a mariner's compass provided with a magnetic-needle-actuated compass card P having a switch *t* mounted rotatable therewith. The compass is also provided with conductors *o*, *s* and *n* and a rotatable transparent face to which said conductors are attached as described in the barometric switch.

If it is desired to travel in any particular direction—say east—the machine is placed with its head in that direction by means of the usual control mechanism. The face of the compass is then rotated until the switch *t* comes midway between the conducting members *s* and *n*, and the battery switched on. If for any cause the head of the machine turns to the right of the course set, the compass card remaining stationary, the switch will come into contact with the conductor *s*, thereby establishing a current as follows: from the battery E through 26, *o*, *t*, *s*, 40, 24, 39 to battery. The attraction of the armature 24′ by the magnet 24, will cause the piston 33 to operate the press C. This causes the operation of the drum controlled by the press C, thus warping the wings so as to elevate the left side of the machine, thereby causing greater resistance to forward progression on that side, and forcing the head of the machine back to the left into the set course, when the circuit again opens, since the magnetic switch remains stationary relative to direction. The abrupt action of the magnet 24 is modified and graduated by the opposing force of the static pressure of the elevated arm *b*, in the manner explained in connection with the barometric control. The drawings show but two pair of drums and presses, but it is self-evident that more may be used in this device; thus, an additional pair of drums and presses may be mounted in connection with the lateral steering rudders and the compass switch to control direction independently of stability. A swing to the left in like manner closes the circuit of the magnet 22, and is corrected through reverse action of the press B and the parts corresponding therewith.

It will be noted that there is no movement of the liquid relative to the tube and press in applying pressure between the corresponding drum and rotating disk; the said pressure being exactly in unison with and proportional to the tipping of the flying machine in a specific direction. The press acts only to multiply the static pressure at the inner end of its lateral tube and transmit the increased pressure through the drum to the co-acting frictional surfaces with no longitudinal movement of said drum.

Changes in the form, proportion and minor details of construction may be resorted to, without departing from any of the principles, or sacrificing any of the advantages of this invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an automatic controller for flying machines, a power driven continuously moving frictional member; a frictional member bearing against said moving member and connected with the stabilizing mechanism in such manner as to move the same, until the reaction balances the friction due to the pressure between the said frictional members; hydrostatic means responsive to tilting of the flying machine, to automatically vary the pressure between said frictional members in unison with and proportional to the said tilting, and without movement of the liquid of said hydrostatic means relative to the flying machine.

2. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried by said shaft, a drum having a por-

tion arranged in engagement with said friction disk, cables carried by the drum, and hydrostatic means automatically actuated by the tilting of the machine without movement of the liquid within its container, for forcing the drum against the disk with a static pressure varying with and proportional to the degree of tilt.

3. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried thereby, a drum disposed concentrically with said shaft and having a portion arranged to engage said friction disk, and a hydrostatic press having a portion disposed concentrically with said shaft and arranged to support said drum, said portion being movable toward and away from said disk to bring the drum into or out of engagement with the disk.

4. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried thereby, a drum disposed concentrically with said shaft and having a portion arranged to engage said friction disk, a hydrostatic press having a portion disposed concentrically with said shaft and arranged to support said drum, said portion being movable toward and away from said disk to bring the drum into or out of engagement with the disk, and means for automatically varying the pressure in the press in accordance with the tilting of the machine.

5. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried thereby, a drum disposed concentrically with said shaft and having a portion arranged to engage said friction disk, a hydrostatic press having a portion disposed concentrically with said shaft and arranged to support said drum, said portion being movable toward and away from said disk to bring the drum into or out of engagement with the disk, and means for automatically varying the pressure in the press in accordance with the tilting of the machine, said last means comprising a laterally extending tube communicating with the interior of the press, said tube containing a liquid.

6. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried by the shaft and revoluble therewith, the plane of the disk being at right angles to the shaft, a hydrostatic press disposed on each side of said friction disk, each of said hydrostatic presses having a portion movable toward and away from said disk, a drum carried by the movable portion of each of said hydrostatic presses, each of said drums having a portion arranged to engage said friction disk, and means for automatically supplying pressure to each of said hydrostatic presses dependent upon the tilting of the machine.

7. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried by the shaft and revoluble therewith, the plane of the disk being at right angles to the shaft, a hydrostatic press disposed on each side of said friction disk, each of said hydrostatic presses having a portion movable toward and away from said disk, a drum carried by the movable portion of each of said hydrostatic presses, each of said drums having a portion arranged to engage said friction disk, and means for automatically increasing the hydrostatic pressure in one of said presses in proportion to the tilting of the machine and for simultaneously decreasing the hydrostatic pressure in the other press.

8. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried by the shaft and revoluble therewith, the plane of the disk being at right angles to the shaft, a hydrostatic press disposed on each side of said friction disk, each of said hydrostatic presses having a portion movable toward and away from said disk, a drum carried by the movable portion of each of said hydrostatic presses, each of said drums having a portion arranged to engage said friction disk, and means for automatically increasing the hydrostatic pressure in one of said presses in proportion to the tilting of the machine and for simultaneously decreasing the hydrostatic pressure in the other press, said means comprising a tube carried by each press and communicating with the interior thereof, each of said tubes being filled with a liquid, said tubes extending in opposite directions.

9. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried by the shaft, a drum slidably mounted and adapted to move longitudinally of the shaft, said drum having a portion arranged to engage the friction disk, a hydrostatic press having a movable portion arranged to support the drum and to move the latter, the interior of the said hydrostatic press being lined with a resilient expansible material, and a tube extending laterally from the side of the press opposite the movable portion.

10. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried thereby, a hydrostatic press mounted concentrically upon said shaft and having a portion movable longitudinally of the latter, a drum carried by said movable portion and having a part adapted to engage said friction disk, a piston for said hydrostatic press, a magnet having an armature connected with said piston, a source of current for said magnet, and a barometric switch for closing the circuit between the source of current and the magnet.

11. In an automatic controller for flying

machines, a revoluble shaft, a friction disk carried thereby, a hydrostatic press mounted concentrically upon said shaft and having a portion movable longitudinally of the latter, a drum carried by said movable portion and having a part adapted to engage said friction disk, a piston for said hydrostatic press, a magnet having an armature connected with said piston, a source of current for said magnet, and a barometric switch adjustable for any altitude for closing the circuit between the source of current and the magnet when the flying machine deviates from the set altitude.

12. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried thereby, a hydrostatic press mounted concentrically upon said shaft and having a portion movable longitudinally of the latter, a drum carried by said movable portion and having a part adapted to engage said friction disk, a piston for said hydrostatic press, a magnet having an armature connected with said piston, a source of current for said magnet, and a compass switch for closing the circuit between the source of current and the magnet.

13. In an automatic controller for flying machines, a revoluble shaft, a friction disk carried thereby, a hydrostatic press mounted concentrically upon said shaft and having a portion movable longitudinally of the latter, a drum carried by said movable portion and having a part adapted to engage said friction disk, a piston for said hydrostatic press, a magnet having an armature connected with said piston, a source of current for said magnet, and a compass switch adjustable for any direction for closing the circuit between the source of current and the magnet when the flying machine is headed out of the given direction.

14. In an automatic controller for flying machines, a normally horizontal receptacle for liquid, the said receptacle of an oblong form, closed at one end and provided with an enlarged opening at the other; a telescoping member closing the enlarged opening of the receptacle; a frictional power transmitting device bearing externally against the said telescoping member so as to prevent outward movement of the same and a sufficient quantity of suitable liquid to fill the inclosed space of the receptacle.

WILLIAM W. SWAN.

Witnesses:
C. D. STERLING,
M. C. H. STERLING.