A. SPRATER.

STABILIZING DEVICE FOR FLYING MACHINES.

APPLICATION FILED SEPT. 22, 1913.

1,119,324.

Patented Dec. 1, 1914.

4 SHEETS—SHEET 1.

Fig. 1.

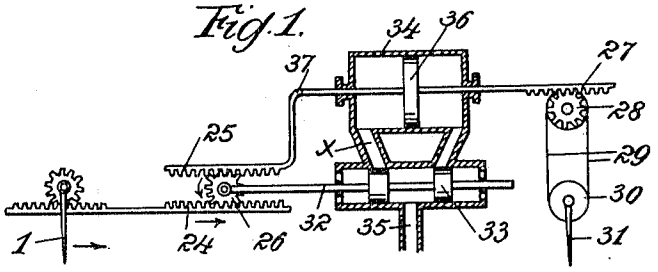


Fig. 2.

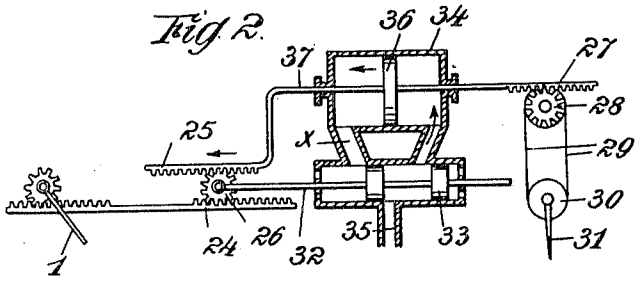
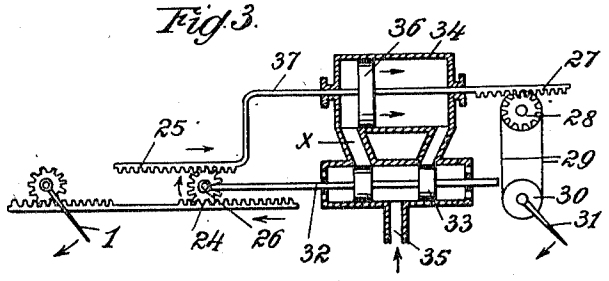


Fig. 3.



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4 SHEETS—SHEET 2.

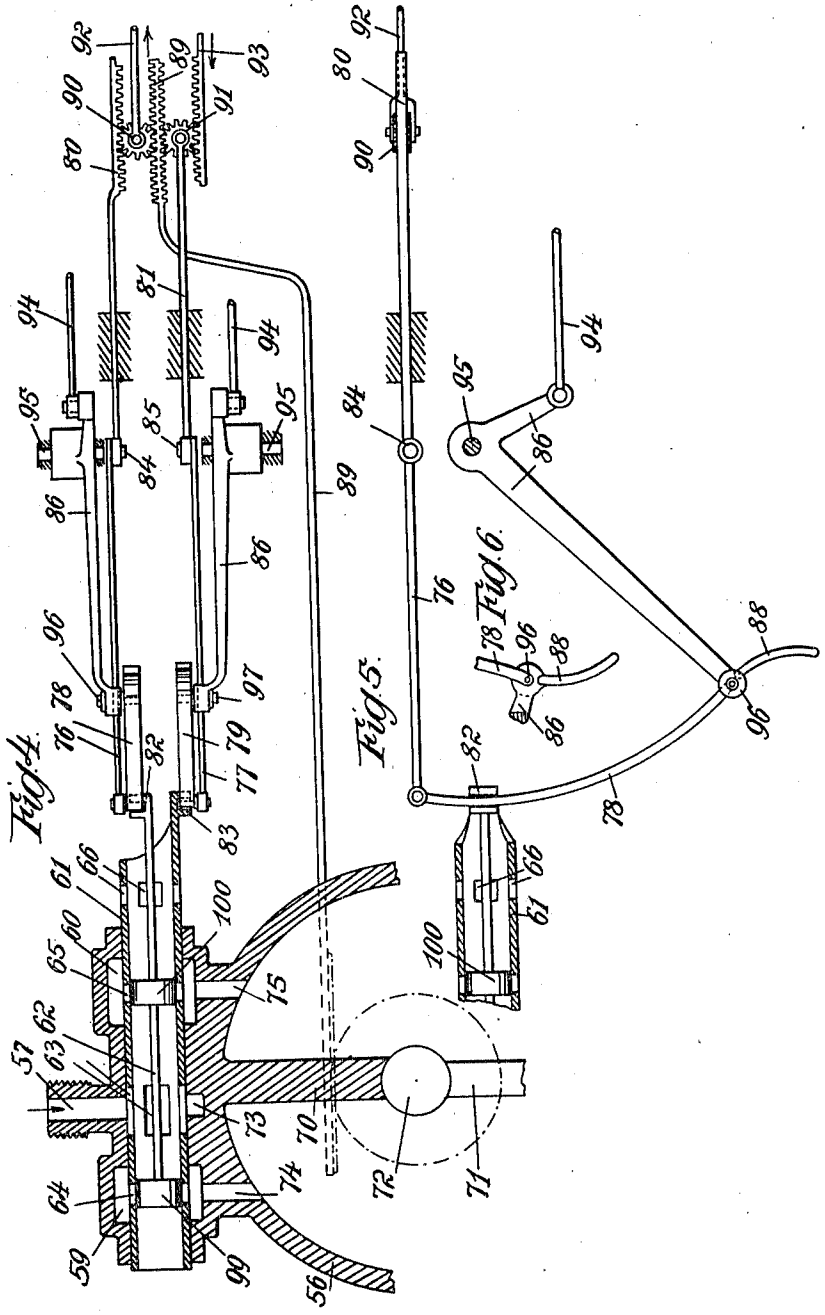


Fig. 4.

Fig. 5.

Fig. 6.

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4 SHEETS—SHEET 3.

Fig. 7.

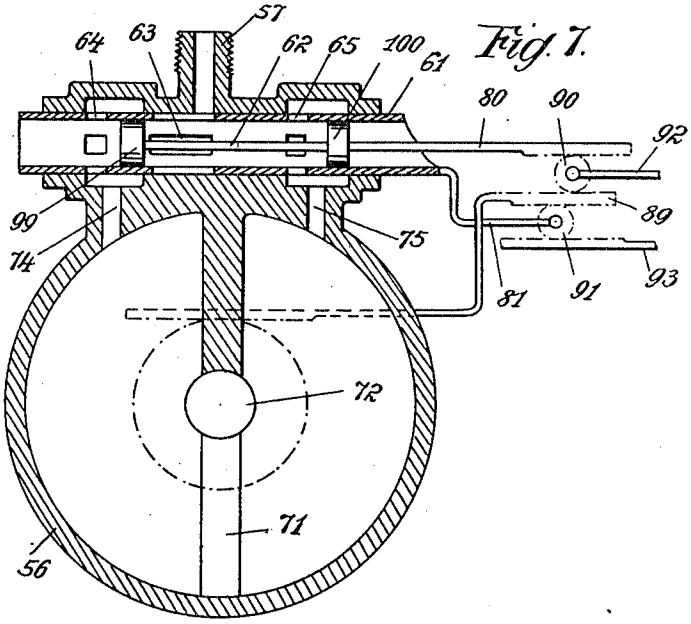
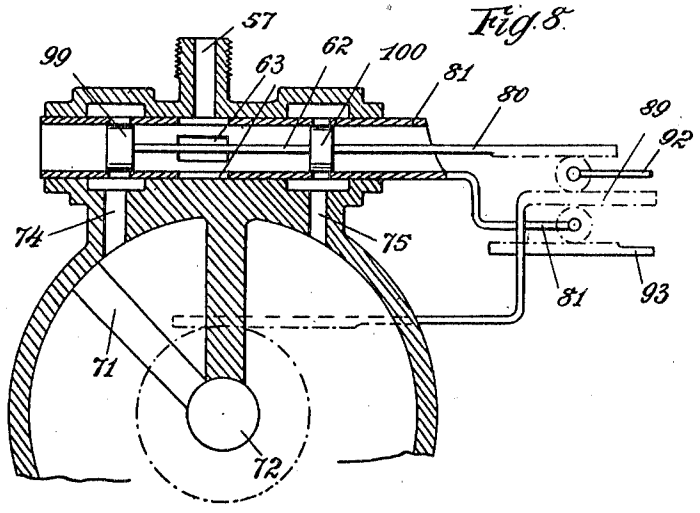


Fig. 8.



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4 SHEETS—SHEET 4.

Fig. 9.

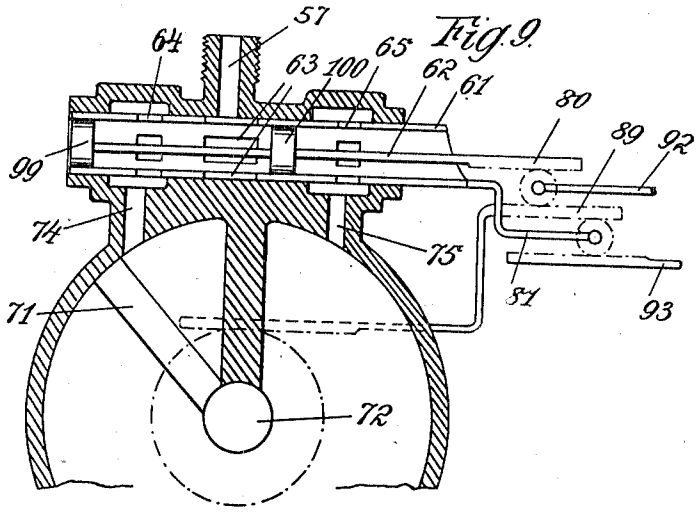
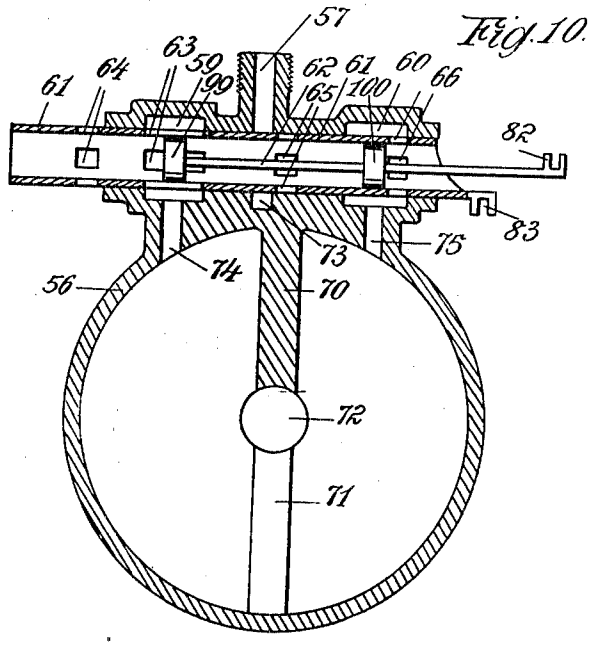


Fig. 10.



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UNITED STATES PATENT OFFICE.

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STABILIZING DEVICE FOR FLYING-MACHINES.

1,119,324. Specification of Letters Patent. Patented Dec. 1, 1914.

Application filed September 22, 1913. Serial No. 791,123.

To all whom it may concern:

Be it known that I, ADOLF SPRATER, engineer, and a citizen of the German Empire, and a resident of Neustadt-on-the-Hardt, Germany, with the post-office address Karolinenstrasse 65, have invented new and useful Improvements in Stabilizing Devices for Flying-Machines, of which the following is a specification.

This invention relates to a development of the means for stabilizing flying machines described in my application for Letters Patent Ser. No. 717106 filed August 26th, 1912. In the said application the point concerned is the adjustment of the flying machine rudder or the like by the deviation of stabilizing members (consisting of feeler surfaces—wind vanes or the like—or weights, or of the two together) in the event of disturbances, this being effected in such a way as to counteract the disturbance and prevent it from having any injurious effect on the stability of the machine.

As already described in the specification of my application identified above, these stabilizing members can act either directly on the equalizing rudder or else are connected with a servo-motor, which in turn effects the adjustment of the rudder in accordance with the action of the stabilizing members.

The present invention relates to the last named modification, being concerned with the special means of transmitting the movements of the stabilizing members to the servo-motor.

In the invention the starting point is a connection between the stabilizing members and the servo-motor, of such a character that when the stabilizing members are no longer in their position of deviation, the intermediate members reverse the servo-motor valve gear for the return movement of the servo-motor into the central position, and thereby cause the flying machine rudder or the like to return to its position of repose.

Additional features and advantages will appear in the following description and in the drawings which represent the invention in several typical forms.

Figures 1 to 3 represent, diagrammatically, the connection between the stabilizing member and the servo-motor, and the manner in which the equalizing rudder is operated by the servo-motor in accordance with the position of the stabilizing member. Fig. 4 shows a servo-motor with double valve and two stabilizing members each operating a valve. Fig. 5 is a side elevation of Fig. 4 and represents the interposed quadrant lever by means of which, as already stated, the stroke of the valve can be modified. Fig. 6 shows a detail of Fig. 5 viewed from the other side. Figs. 7 to 9 represent various intermediate positions of the arrangement according to Fig. 4. Fig. 10 shows the over-set position of the distributing valve and the consequent exclusion of the supply of operating medium from the servo-motor.

In the forms according to Figs. 1 to 3, the stabilizing member, for instance a wind vane, 1, acts on a rack 24 engaging with a pinion 26. This pinion is carried on the end of the rod 32 of the piston valve 33 of a servo-motor 34. The operating medium, which may consist of compressed air, liquid under pressure, etc., is admitted at 35. The working piston 36 of the servo-motor 34, or the piston rod 37, is provided at each end with racks 25, 27. The rack 25 meshes with the pinion 26 of the distributing valve, and the rack 27 with a pinion 28, the shaft of which is connected to the shaft of the flying machine rudder 31, by a cord drive 29, 30.

The device according to Fig. 1 works in the following manner. When the stabilizing device 1 is at rest, the parts take up the position shown in Fig. 1. Assuming now that the wind vane 1 flies out to the right, in the direction of the arrow, then the parts will take up the position shown in Fig. 2; that is to say, the rack 24 will cause the pinion 26 to travel along the rack 25 (which is still at rest for the moment), thus displacing the rod 32 of the distributing valve 33 toward the right, so that the operating medium can enter behind the right face of the working piston and force the piston toward the left, that is to say, in the direction indicated by the arrow in Fig. 2. In the course of this movement, the rack 27 causes the pinion 28 to turn and thus moves the rudder 31 to such an extent that this rudder takes up exactly the same position as the wind vane 1, that is to say, is veered toward the right. The movement of the working piston 36, however, also results in a displacement of the rack 25, whereby the pinion 26 travels toward the left along the rack 24 (which must still be regarded as stationary) so that as shown in Fig. 3, the distributing valve 33 is brought into the inoperative position. If now, the stabiliz-

ing member 1 leaves its position of deviation, the rack 24 is moved toward the left (in the direction of the arrow in Fig. 3) that is to say, is returned to its original position as in Fig. 1. In this movement, however, the pinion 26 is caused to roll away over the momentarily stationary rack 25, and the distributing valve 33 is moved toward the left so as to admit the operating medium into the admission part X and drive the piston 36 in the direction of the arrow, that is to say, toward the right. In this movement toward the right, however, the pinion 26 is at the same time rolled back along the rack 24, and the distributing piston 33 is brought into the inoperative position. Through the displacement of the rack 27 toward the right, the equalizing rudder 31 is also returned to its central position, so that all the parts again occupy the position marked in Fig. 1.

To enable the rudder to be operated by hand independently of the servo-motor or stabilizing member, and the stroke of the distributing valve 33 to be modified as required, the arrangement as described below, in connection with Figs. 4 and 5, can be interpolated in the rod 32.

In the modification according to Fig. 4, in place of a servo-motor with reciprocating piston as in Fig. 1, use is made of a servo-motor 56 having a piston 71 which revolves around a shaft 72. The admission of the operating medium to, and the exhaust from, the two sides of the partition 70, are effected through ports 74, 75 communicating with chambers 59, 60 in the valve casing. The pressure medium is admitted at 57, the admission passage forming an annular chamber 73 around the valve.

The distributing valve is arranged as a double slide valve. In the external cylindrical slide 61, travels the inner slide 62, consisting of two pistons 99, 100. The pistons 99, 100 of the inner slide coact with openings or ports 64, 65 in the outer slide so that according to the relative position of these pistons to the openings 64, 65, the pressure medium can act on the piston 71, either from the right or the left, or it may be excluded as is assumed to be the case in Fig. 4. The outer slide 61 is also provided with openings 63 and 66, of which 63 serves to admit the operating medium, while 66 has a special purpose described below. With the inner slide 62 engages a rod 76, which is articulated at 84 to a rack rod 80, which engages with a pinion 90 carried by a rod 92. The rod 92 is operated by a stabilizing member, such as a weight. The outer slide 61 is controlled by a rod 77, which is articulated at 85 with a rod 81. The free end of the rod 81 carries a pinion 91 which receives motion from a rack 93 connected to a second stabilizing device, for example a wind vane. A rack 89 arranged between the two pinions 90, 91 is connected, through pinion gearing at the opposite end, with the motor shaft 72 and, as will be described later, serves to return the parts into the inoperative position.

In the example shown, the rods 76, 77 do not engage directly with the slides, each being articulated to a quadrant lever 78, 79. Each quadrant is articulated at 96 and 97 respectively to a bell-crank-lever 86 adapted to swing on a pivot 95, and is guided at 82 (83) in a slot in the corresponding slide, after the manner of a link motion for a steam engine. The second arm of each bell-crank-lever 86 is connected with a hand operated rod 94.

Each bell-crank-lever 86 is provided with a forwardly bent extension 88 pointing in the direction of the corresponding quadrant lever, as shown in Figs. 5 and 6. This extension, 88, hereinafter referred to as a throw-off, serves to throw the servo-motor entirely out of action.

The modification according to Fig. 4 works in the following manner: Assuming that in all cases only one of the rods 92, 93 moves (which is possible because, for example, the stabilizing weight need not share the movement of the stabilizing vane) then the operations attending the adjustment of the distributing valve are essentially the same as in the modification according to Figs. 1 to 3 the whole arrangement of the rods according to Fig. 4 being, in reality, nothing more than a duplication of the arrangement according to Fig. 1. When both rods 92, 93 are displaced at the same time, they describe opposite movements originating in the divergent character of the two stabilizing members under consideration. When both rods 92, 93 move in the direction of the arrow shown in Fig. 4, the parts of the distributing valve pass from the position shown in Fig. 4, first of all into that shown in Fig. 7, that is to say, the inner slide 62 is moved toward the right by the rack 80, and the outer slide 61 toward the left by the rack 91. This displacement must take place, because the central rack 89 is still at rest. When the position shown in Fig. 7 is reached, the pressure medium flows through the ports 63, 60, 65 and 75 behind the right face of the piston and cause the same to turn around toward the left into the position shown in Fig. 8. During this rotary movement the rack 89 is moved to the right and thus displaces the rods 80, 81 in such a manner as to shut off the supply of the operating medium. This is possible because the rods 92, 93, are at rest for the time being. As the piston 71 rotates from the position in Figs. 4 and 7 into the position shown in Fig. 8, the motor shaft 72 turns the flying machine rudder (no longer

shown in the figures) into such a position as to render innocuous the cause of disturbance to the stability of the flying machine as taken up by the stabilizing member. The parts remain in the position shown in Fig. 8 until the stabilizing member has returned into the inoperative position, the rods 92, 93 moving in the direction opposite to that assumed in Fig. 4, and (since the rack 89 still, at first, remains as in Fig. 8) thus displace the control rods 80, 81 so that the pressure medium can enter on the left and force the piston 71 back into the central position. By this operation the motor shaft 72 also sets the equalizing rudder into the inoperative position. At the same time, however, the rack 89 is also drawn back, thus pushing the parts 80, 81 again in such a way that the double slide is returned to the inoperative position and finally again reaches the original position shown in Fig. 4.

When it is desired to modify the valve stroke, all that is needed is to set the quadrant lever 76 or 77 higher or lower thus bringing the point of articulation 96, 97 nearer to or farther from the point of operation 82, 83. Each of the quadrant levers 78, 79 swinging about 96, or 97, will describe a movement of more or less extent according to the distance between 82 and 83 and 96, 97, thus determining the stroke of the valve. If it be desired to throw the servo-motor out of action entirely, or operate the flying machine rudder by hand, without the stabilizing member, the double slide is brought, by means of the throw-off 88, into the position shown in Fig. 10. In this position the supply of operating medium is shut off and both sides of the piston are placed in communication with the outer air through the openings 63, 66. Hence the piston and those parts of the flying machine that are connected with it, have free play, without it being necessary to provide the return stroke rod 89, or the stabilizing members or their rods 92, 93 with a locking device.

From Fig. 10 it will be clear that the slide of the servo-motor can only be overset in the direction beyond the inoperative position of the servo-motor, thus affording a guarantee that the motor-piston in a working position will return to the middle position before the pressure medium is shut off.

Of course, so far as the details are concerned the invention can be modified in various ways provided the fundamental principle be adhered to. The servo-motor may be of any desired type, as also the distributing valve. However the details are carried out, it is essential in all cases that the new method of connection between the servo-motor and stabilizing member should enable the displacement of the distributing valve under the influence of the deviation or mass displacement of the stabilizing member, to be of any convenient dimensions without difficulty in contrast to formerly, where it was compulsory to keep the valve movement very small because the adjusting force was allowed to act on the (for the most part shorter) end of a double lever mounted on the control rod of the servo-motor. The greater the controlling movement, however, the higher is the opening velocity and therefore the smaller the errors due to inaccuracy in adjustment.

Now what I claim and desire to secure by Letters Patent is the following:

1. In a flying machine, the combination of a rudder, stabilifying mechanism comprising a motor to actuate the rudder, valve mechanism adapted in extreme positions of the valve to admit an actuating medium to the motor, and a stabilifying element to actuate the valve, and means to return the valve to its intermediate position simultaneously with the actuation of the rudder comprising a rod connected to the stabilifying element, a second rod connected to the valve, and a third rod connected to the motor, said second rod provided with a rotatable member coöperating with the other two rods whereby a movement of the first rod by the stabilifying element rotates said member on the third rod and thereby actuates the second rod and the valve connected therewith, the movement of the motor serving to actuate the third rod to rotate said member on the first rod and thereby return the second rod and valve connected therewith to the intermediate position.

2. In a flying machine, the combination of a rudder, stabilifying mechanism comprising a motor to actuate the rudder, valve mechanism to control the flow of motive fluid to and from the motor, a stabilifying element to actuate the valve, and toothed gearing associated with said valve, stabilifying member and motor, whereby the stabilifying member actuates the valve, the valve actuates the motor, and the motor returns the valve to neutral position.

3. In a flying machine, the combination of a rudder, stabilifying mechanism comprising a motor to actuate the rudder, valve mechanism to control the flow of motive fluid to and from the motor, a stabilifying element to actuate the valve, and toothed gearing comprising racks and pinions associated with said valves, stabilifying member and motor, whereby the stabilifying member actuates the valve, the valve actuates the motor, and the motor returns the valve to neutral position.

4. In a flying machine, the combination of a rudder, stabilifying mechanism comprising a motor to actuate the rudder, a valve associated with said motor, actuating means

for the valve comprising a stabilifying member, connections between the valve and stabilifying member comprising an arc-shaped lever slidably connected with the valve, and an extension on said lever so bent as to produce an excessive displacement of the valve when the extension engages therewith.

5. In a flying machine, the combination of a rudder, stabilifying mechanism comprising a motor having a piston to actuate the rudder, a double slide valve associated with said motor having co-axially disposed inner and outer valves, the outer valve having two openings and the motor having passages to admit or exhaust the motive fluid to or from either side of the piston and with which said openings are adapted to register in an extreme position of said outer valve, both sides of the piston being in communication with the atmosphere when the outer valve is in said extreme position and when the inner valve is in its intermediate position.

In testimony, that I claim the foregoing as my invention, I have signed my name in presence of two witnesses, this 11th day of September, 1913.

ADOLF SPRATER.

Witnesses:

RICHARD KAUFMANN,

HEINRICH RÜCKLOR.