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CONTROL OF MOVING CRAFT

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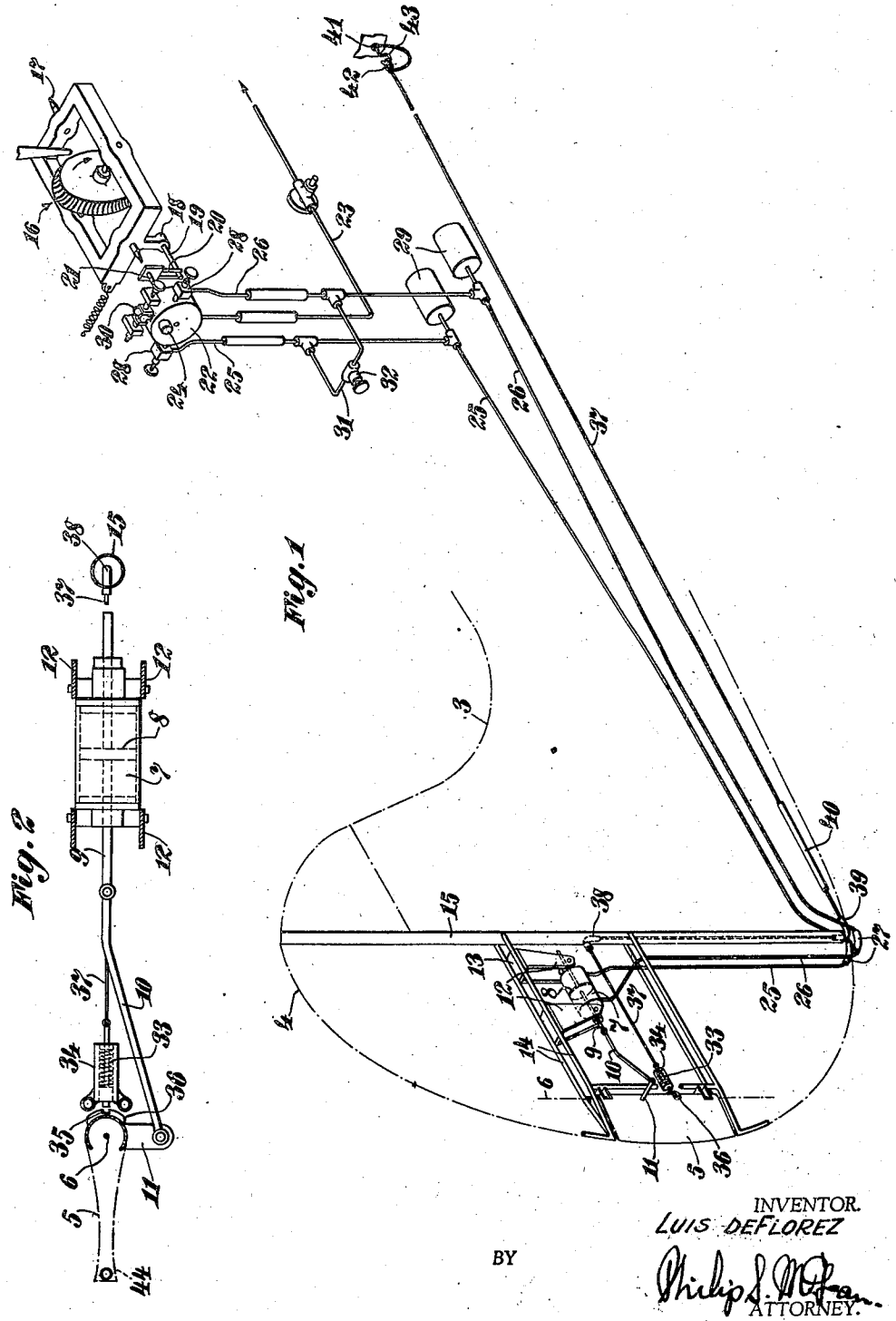


Fig. 1

Fig. 2

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CONTROL OF MOVING CRAFT

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1 Claim. (Cl. 244—87)

The present invention relates to control of the direction of movement and attitude of moving craft generally, but more particularly aircraft.

In prior installations as typified in Luis de Florez Patent 2,162,940, June 20, 1939 and patent application Ser. 139,868 filed April 30, 1937, directional control has been effected through the medium of a sensitive rate of turn instrument operating a valve to control differential pressures in a cylinder connected to actuate rudder, ailerons, elevators or other control surfaces. In some instances, so-called booster valves were interposed in the differential pressure lines to accomplish a power amplifying effect.

This amplification of power for directional and attitude control is especially desirable, and in some instances, necessary in the automatic handling and control of large size aircraft.

One of the objects of the present invention is to obtain all necessary power amplification without having to resort to booster valves or like amplifying equipment. This is accomplished by utilizing the kinetic energy present in the air or other medium in which the craft operates, for example, by the provision of a movable tab in the control surfaces to be governed, said tab being directly actuated by a servo motor mounted in the control element and controlled through differential pressure lines from a rate of turn instrument, which may be disposed to respond to turn about any one or more axes.

By so combining and arranging the parts, a relatively small light weight power cylinder, of a size which can be readily mounted within a rudder or other control surface and which can be directly controlled from a sensitive differential pressure valve actuated by the rate of turn instrument may be all that is required in the way of power equipment for effecting operation of a given control surface.

Another feature of the invention is the provision of a special tab lock by which the control tab may be secured against movement when the automatic equipment is not in service, as when the pilot may taken over for manual control and which can be immediately released when the automatic control is cut into service.

Other features and objects of the invention and details of construction are set forth in the following specification, illustrated in the accompanying drawing and broadly covered in the claim defining the invention.

The drawing illustrates one typical embodiment of the invention, it being contemplated that the structure may be changed and modified within the true spirit of the invention, all within the intent and scope of the following claim.

In the drawing, Fig. 1 is a perspective and generally diagrammatic view illustrating the invention embodied in a form of rudder control.

Fig. 2 is an enlarged broken part sectional plan and detail view of the power and tab locking portions of the apparatus.

In the present illustration, an airplane is indicated at 3, having a rudder 4.

Mounted in and forming a part of the surface of the rudder, there is shown a control tab 5, journalled to rotate on the vertical axis 6.

7 designates a small power cylinder located within the rudder surfaces and containing a piston 8, having a projecting rod 9, connected by pivot link 10, with the horn 11, of the rudder tab.

The cylinder is shown supported in U-brackets 12 attached at 13 to rods 14 connected with the rudder post 15.

At 16, a rate of turn gyroscope is indicated, rocking on an axis 17 which in this illustration is in line or substantially in parallel with a longitudinal axis of the aircraft. The frame of this gyroscope is shown as having an arm 18 carrying a pin 19 in engagement with lever 20 on the arbor 21 of a differential valve element operating within valve casing 22. Details of these parts are fully shown and described in the de Florez patents above identified, so it is sufficient for the present disclosure to understand that 23, is the suction line connected with a vacuum pump, venturi, or other suction creating means, that 24, is the air filter providing inlet of air into the valve casing and that 25, 26, are the two differential pressure lines extending from opposite sides of the valve casing to opposite ends of the servomotor cylinder and according to position of the valve element, adapted to be subjected to equal or to varying unlike degrees of suction and, or atmospheric pressure. These differential pressure lines are shown brought out at the stern of the ship and extended up through the rudder, back of the pivot post with flexible couplings 27, interposed where the lines cross the pivotal center.

The differential pressure lines are shown as having adjustable valve restrictions 28, and vacuum capacity tanks 29, for governing and regulating the application of the control forces to bring the craft, when a deviation occurs, back on the course, without over-swinging or setting up a "hunting" effect, as disclosed in the first de Florez patent mentioned. Also the valve casing is shown as adjustable at 30, for course changing

purposes and the differential pressure lines as having a connection 31 with a valve 32, which can be opened to render the automatic control inoperative, all as fully covered in said patent, the design of the present invention enabling advantageous use of those improvements.

When not in service, the tab can be locked to form an integral part of the total rudder control surface by means consisting in the present disclosure of a spring pressed plunger 33, guided in a casing 34, and adapted to enter a notch 35, in segment 36, on the forward edge of the tab. For purposes of releasing this lock, a wire or cable 37, is shown extended through a curved guide 38, into the tubular rudder post and out through a second curved guide 39, at the foot of the post into a fixed guide 40, in the fuselage. This lock control wire may be carried up into the cockpit, control cabin or to some other convenient position. It is shown as secured at 41 and as carrying a ring 42 which can be caught over a hook 43 to hold the lock plunger pulled out of the notch and the tab thus free for control purposes. To lock the plunger the ring need simply be released from the hook. If the plunger is let go at a time when the notch is out of line, the nose of the plunger will simply ride the surface of the segment until the tab swings back in line with the rudder surface, which it will naturally do when control of same is relinquished.

In the condition illustrated in Figure 1, the locking pin 33, is withdrawn and the control tab 5, is free to be operated by the servomotor 7. Upon the start of a turn, the gyroscope will rock the movable element of control valve 22, one way or the other, depending on the direction of turn, thus to apply different degrees of suction, or in some instances, suction through one line and atmospheric pressure at the other, through the two differential pressure lines 25, 26. Subjected to such differential pressures, the servomotor piston 8, will move one way or the other, to turn the tab in a direction and to an extent necessary to enable it to swing the rudder in the direction and to the amount required to bring the craft back on to its course or approximately so. In this manner, a relatively small low power servomotor, of a size which can readily go within the control surface member and which does not add objectionable weight to that member, can be utilized to automatically effect all control adjustments. Being disposed practically at the point of control, there is no undesirable lag or delay in initiating or completing the necessary control adjustments. The promptness of action thus attained makes the device more sensitive in effect, enabling the flow restricting control valves 28, for instance, to be more fully opened up, so that the servomotor will come into action, substantially at the instant the gyro detects a change in direction or attitude.

The ship may thus be maintained under better control because corrections are made before deviations reach any real magnitude. With the flow restricting valves opened up the capacity tanks 29 are made more quickly responsive. In some instances, where capacity of the cylinder and connecting lines is sufficient, the tanks may not be used. The quick acting tab control may thus have this additional advantage of eliminating need for capacity tanks in the control equipment.

When desired, the automatic control can be cut out of service by either opening up the bypass valve 32, which has the effect of short-circuiting the servomotor cylinder, or by releasing the ring 42 from the hook 43 to permit the lock pin to drop into its notch in the tab, to secure the tab in rigid locked position where it will form part of the normal rudder surface. Then, in either event, or, if both the servomotor has been cut out of action and the tab secured in locked condition, the plane may be controlled by the pilot in the usual manner. Even with the automatic tab control in service the parts are preferably such and so related that the pilot can overpower and exercise manual control at any instant.

While shown only in conjunction with rudder control, it will be clear that the principles of the invention may be applied to aileron, elevator or other control, equally within the scope of the invention. The air cylinder form of servomotor is light in weight and can be dimensioned to be enclosed wholly within the control member. Other forms of servomotors, however, may be employed. If desired, the system can be designed to operate under positive pressure instead of under partial vacuum, as illustrated. Only a small amount of power is required to swing the control tab, so the pressure creating means and the connections from the same to the servomotor can be relatively light and small. The control valve can be made light enough to be easily operated by the rate of turn gyroscope, without retarding or impairing the sensitivity of the latter. While the control tab is capable of effecting the full control movements of the rudder or other control surface, in some instances, it may be utilized simply in an "assisting" relation, for instance, as an aid in the manual piloting of a ship. Change from automatic to full manual control can be instantly effected by simply opening the differential pressure bypass valve or by unhooking the ring of the pull cable to let the lock bolt drop into the securing notch in the rudder tab. The tab is then positively held and forms a continuous part of the rudder surface. To overcome possible effects of partial vacuum at the trailing edge of the tab and to render the tab more effective in the slip stream, the tab may be outlined as indicated in Fig. 2, with the sides flaring to the rear at 44.

What is claimed is:

In combination with a craft having a movable control surface, a control tab set in said movable control surface and operable independently thereof, means for effecting independent control movements of said control tab and means for locking said control tab against such independent movements and including a segment with a center notch, a movable locking element engageable with said segment and in said notch, a spring thrusting said locking element toward said segment, a pull line connected with said movable locking element for drawing the same away from said segment and means for holding said pull line in different positions of adjustment either free of said segment or yieldingly engaged therewith and free to enter said notch.

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