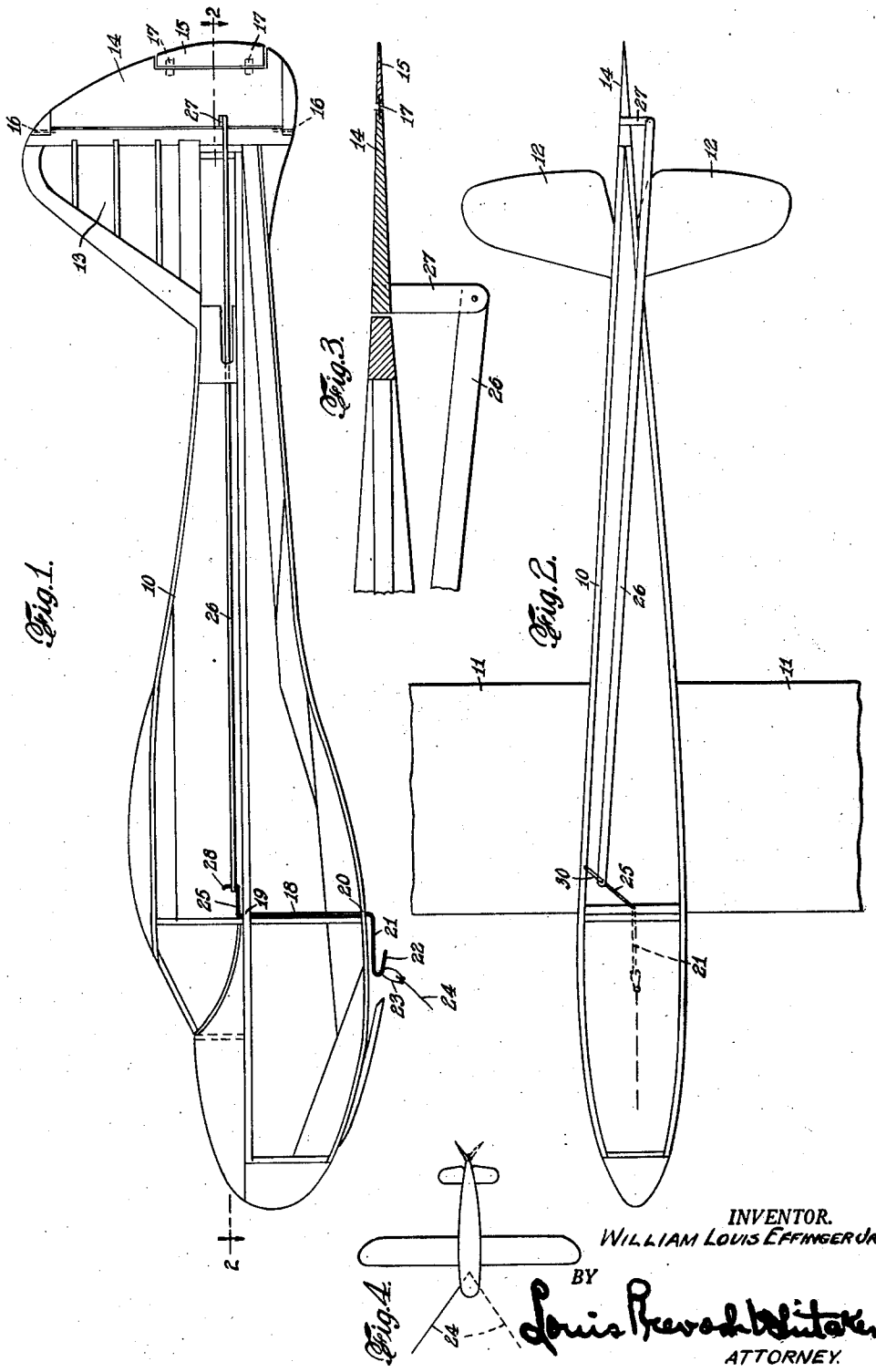
April 10, 1945. W. L. EFFINGER, JR 2,373,236

TOW CONTROL FOR GLIDERS

Filed May 11, 1943



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Patented Apr. 10, 1945

2,373,236

UNITED STATES PATENT OFFICE

2,373,236

TOW CONTROL FOR GLIDERS

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Application May 11, 1943, Serial No. 486,494

7 Claims. (Cl. 244—3)

The present invention relates to the control of towed gliders to keep the glider on its course automatically without the need of manual control. The invention is thus particularly applicable for use where a glider is flown without a pilot, as for example, a model glider.

A glider may be towed continuously, for example, by a power plane, or it may be launched by a tow line and then allowed to soar freely until it lands. In the latter case the glider is towed until it attains sufficient altitude, whereupon the pull on the tow line is discontinued, and the tow line is preferably released from the glider so as not to impede its flight. In the present application the invention is shown by way of example embodied in a glider intended for tow line launching, but the towing can obviously be continued as long as desired.

It is an object of the present invention to provide an automatic control for keeping a glider on its course while it is being towed. In accordance with the invention this is accomplished by providing the glider with movable control surfaces which are operated automatically by the direction of pull on the tow line to steer the glider. Another object of the invention is to prevent "overcontrol" causing the glider to overshoot its course, first to one side and then to the other so that it flies in a zig-zag fashion. A further object of the invention is to provide for automatic control during the launching of a tow line launched glider, and also control of the direction of flight of the glider after the tow line has been released. In accordance with my invention the objects are attained by control mechanism which is of strong and simple construction reliable in its operation and of such light weight that it does not substantially increase the overall weight of the glider.

Further objects and advantages of my invention will be understood from the following description of an embodiment, selected to illustrate the invention and shown by way of example in the accompanying drawing, in which

Fig. 1 is a side elevation of a glider embodying my invention with portions of the body structure broken away to show the control mechanism.

Fig. 2 is a view taken approximately on the line 2—2 in Fig. 1.

Fig. 3 is an enlarged fragmentary horizontal sectional view taken on the same line as in Fig. 2.

Fig. 4 is a small scale diagrammatic view illustrating the operation of the control mechanism in accordance with my invention.

In the drawing, the invention is shown embodied in a tow line launched glider. The glider has a body structure comprising a fuselage 10, wings 11, horizontal stabilizers 12 and vertical stabilizer 13, and is provided with movable control surfaces for controlling the direction of flight of the glider. In the embodiment illustrated in the drawing, the control surfaces are provided in the form of a rudder 14, and a trim tab 15. The rudder is swingable about a vertically extending axis provided by hinge pins 16. The trim tab 15 is shown hinged to the rudder by means of hinges 17 preferably formed of pieces of sheet metal secured to both the rudder and the trim tab so that the position of the trim tab can be adjusted by bending the metal hinges, whereupon the tabs will be held in adjusted position.

In accordance with the present invention the position of movable surfaces controlling the direction of flight of the glider during towing is automatically controlled by the direction of pull of the tow line. The automatic control is achieved by means of a control element responsive to changes in direction of pull of the tow line and connected with control surfaces to change the position of said surfaces upon change in direction of the tow line pull. In the form shown by way of example in the drawing, the control element comprises a vertically extending shaft 18 rotatably supported in the glider structure by bearing 19 and 20 and having at its lower end an arm 21 which projects forwardly from said shaft and is provided at its forward end with means for releasably attaching a tow line. For example, the forward end of the arm is bent to form a rearwardly and downwardly opening hook 22 over which a loop 23 of the tow line 24 may be slipped. The arm 21 and hook 22 are located below the fuselage so that the tow line can be readily attached and detached. The shaft 18 is also provided with an arm 25 which projects laterally from the shaft and is shown at an angle of approximately 45° to the longitudinal axis of the glider. The arm 25 is connected by a link 26 with an arm 27 projecting laterally from the rudder 14. It will be seen that the arm 25 of the control element and the arm 27 of the rudder project toward opposite sides of the glider and that the link 26 crosses over from one side to the other. Hence if the control element is turned in a counterclockwise direction as viewed in Fig. 2 about the vertically extending axis determined by the bearings 19 and 20, the link 26 will be moved forwardly and the rudder will be swung in a clockwise direction about the vertically extending axis determined by hinge pins 16. Conversely, if the control element is turned in a clockwise direction the rudder will

be swung about its hinge pins in a counterclockwise direction. It will be understood that in referring to the axes of the control element and the rudder as being vertically extending, and hence approximately parallel to one another, it is meant that they extend in a generally up and down direction and need not be perpendicular to the longitudinal axis of the glider or to the horizontal plane passing through the longitudinal axis. The axis about which the rudder swings is frequently inclined, and the axis of the control element may also be inclined, if desired. The control element can conveniently be made of a single piece of wire or rod bent to provide the forwardly projecting arm 21, the hook 22 and the laterally projecting arm 25 including a pivot pin 28 for pivotally connecting the glider arm with the link 26.

The control element is preferably held in a predetermined position by a resilient element 30 for example an elastic band or a spring attached at one end to the arm 25. The other end of the spring is anchored to the body structure and the anchoring point may, if desired, be made movable or adjustable in order to vary the position in which the control element is held. The resilient element may be attached in other ways to hold the control element in predetermined position. For example, a resilient element may be attached to another arm provided on the control element or opposed resilient elements acting in opposite directions may be attached to arm 25 or other arms with which the resilient element is provided. By reason of the link 28 connecting the rudder with the control element, the rudder is likewise held in predetermined position by the resilient element 30. It will be seen that the resilient element opposes movement of the control member from neutral position and tends to return it to said position if it has been displaced. If desired, suitable damping means, for example, a dash pot may be provided to prevent oscillation of the control element. However, this is not ordinarily necessary, particularly if the resilient element 30 is in the form of an elastic band having a certain amount of internal friction.

In flying the glider shown by way of example in the drawing, the tow line attached to the hook 22 of the forwardly projecting arm 21 of the control element and the other end of the line is pulled by the moving object by which the glider is to be towed. For tow line launching, the point of attachment of the tow line to the control element and hence to the glider is preferably below and forward of the center of gravity of the glider and, as will be apparent from Fig. 1, well below the center of lift and center of resistance of the glider so that a pull on the tow line creates a couple causing the glider to be inclined upwardly at a proper angle of attack for climbing. As long as the pull on the tow line is straight ahead, the control element remains in its neutral position. However, if the direction of pull is changed either by changing the direction of the towing object, or by reason of the glider getting off its course as might happen if the glider were struck from the side by a gust of wind, the pull on the tow line will be toward one side of the glider, as illustrated diagrammatically in Fig. 4, and will tend to swing the control element about its axis. Thus, if the pull of the tow line is toward the right, as shown in solid lines in Fig. 4. the control element will be swung in a clockwise direction and the rudder will be swung in a counterclockwise direction more toward the right. This will swing the tail of the glider to the left and hence turn the glider to the right. As the plane turns toward the direction of pull of the tow line, the sidewise pull on the arm 21 of the control element is progressively decreased and the control element will be restored to its neutral position as soon as the glider is again headed in the direction of pull of the tow line. It will thus be seen that the amount the rudder is swung by the control element depends on the direction of pull of the tow line. If the direction of pull on the tow line is toward the left side of the glider, the rudder will likewise be swung toward the left, as shown by dotted lines in Fig. 4 and the glider will by reason of the left rudder turn to the left until its deviation from the course determined by the direction of pull on the tow line has been corrected. It will be understood that when the glider is above the towing object, as occurs for example in launching a glider by towing it from the ground, the tow line will pull downwardly as well as forwardly as illustrated in Fig. 1. In this case the direction of flight of the glider is determined by the horizontal component of the pull of the tow line, i. e., a component perpendicular to the pivotal axis of the control element.

The resilient element 30 opposes movement of the control element by a sidewise pull from the tow line, and thereby keeps the control element from being swung as far as it would otherwise. This resilient damping of the action of the control element prevents any "overcontrol," i. e., any tendency to over correct the deviation from the prescribed course and swing first to one side of the course and then to the other in a zig-zag fashion.

When sufficient altitude has been attained in tow line launching, the pull on the tow line is released, and the tow line drops off the hook 22. After the tow line has been released from the control element, the control element and rudder are held in neutral position by the resilient element 30. Ordinarily, this predetermined position will be with the rudder in line with or parallel to the longitudinal axis of the glider. If it is desired for the glider to fly in a circle after being released, the trim tab 15 is adjusted to one side or the other before launching the glider to obtain the circular course desired. Alternatively, by changing the position of attachment of the resilient element 30 it can be made to hold the rudder in any desired position when there is no pull on the tow line. Thus by adjusting the control element or by means of other control surfaces such as the trim tab 15, the glider can be made to fly along a course off-set from the course of the towing object.

While in the embodiment shown in the drawing the control element responsive to the pull of the tow line controls a single rudder, it will be understood that the invention is equally applicable to twin tail gliders and to the control of other vertical or horizontal control surfaces, for example, movable surfaces used in steering a flying wing type of glider. In referring to vertical and horizontal with reference to the glider in the specification and the accompanying claims, it will be understood that the reference is to vertical and horizontal direction when the glider is in a level position and will accordingly vary with variations in the position of the glider.

While the control mechanism in accordance with my invention is extremely simple in construction, it has been found to be effective and reliable in operation. During towing the glider

is kept on its course by the automatic manipulation of the rudder, by the control element responsive to the direction of pull of the tow line. When the tow line is released, control of the glider may, if desired, be taken over by any other control provided. For example, the course may be controlled manually or by a predetermined setting of auxiliary control surfaces such as trim tabs. Alternatively, the direction of flight of the glider after release of the tow line may be determined by the position in which the rudder is held by the resilient element acting on the control mechanism.

What I claim and desire to secure by Letters Patent is:

1. In a glider towed by a towline, the combination of a rudder swingable about a vertically extending axis, a control element adapted to be releasably connected with the towline at a point below the center of gravity of the glider and swingable about a vertically extending axis by changes in the direction of pull of said towline, and connections between the control element and the rudder to swing the rudder in a clockwise direction when the control element is swung counterclockwise, and to swing the rudder in a counterclockwise direction when the control element is swung clockwise.

2. In a towline launched glider having a body structure and a rudder for controlling the direction of flight of the glider, a control element pivotally supported by said body structure for movement about a vertically extending axis and comprising a member having a lower portion projecting below said structure and provided with a downwardly and rearwardly opening hook projecting forwardly from said axis and adapted to receive a towline, and an upper portion provided with an arm projecting laterally from said axis, and means connecting said last mentioned arm with the rudder.

3. In a towline launched glider, the combination of a control element swingable about a vertically extending axis, means for releasably attaching a towline to said element at a point forwardly of said axis and below the center of resistance of the glider in such manner that a pull on the tow line creates a couple causing the glider to be inclined upwardly at a proper angle of attack for climbing, said control element being responsive to the horizontal component of the direction of pull of the towline, a rudder for controlling the direction of flight of the glider, and connections between the rudder and said control element to change the position of the rudder by a change in the direction of pull of the towline.

4. In a towline launched glider, the combination of a control element swingable about a vertically extending axis, means for releasably attaching a towline to said element at a point forwardly of said axis and below the center of resistance of the glider in such manner that a pull on the towline tends to increase the angle of attack of the glider and to swing said control element about its axis in accordance with the direction of said pull, a rudder for controlling the direction of flight of the glider, connections between the rudder and said control element for changing the position of the rudder upon change in the direction of pull of the towline, and means for dampening said changes in rudder position.

5. In a towline launched glider, the combination of a movable control surface for controlling the direction of flight of the glider, a movable control element for controlling the position of said surface, means for resiliently holding said control element and control surface in a predetermined position to steer the glider when in free flight, and connections between said control element and towline to control the direction of flight of the glider by changing the position of said control surface in accordance with the direction of pull of said towline when the glider is being towed, said towline being attached to said control element at a point below the center of lift of the glider in such manner that a pull on the towline creates a couple causing the glider to be inclined at the desired angle of attack.

6. In a towline launched glider, the combination of a rudder, means for resiliently holding said rudder in a neutral position, an adjustable trim tab for directing the glider on a predetermined course when said glider is in free flight with the rudder held in neutral position, and a control element responsive to the direction of pull of a towline and connected with said rudder to change the position of the rudder upon a change in direction of said pull while the glider is being towed, said towline being attached to said control element at a point below the center of lift of the glider in such manner that a pull on the towline creates a couple causing the glider to be inclined at the desired angle of attack.

7. In a towline launched glider, the combination of a control element responsive to the direction of pull of the towline and having an angularly movable portion, a control surface for controlling the direction of flight of the glider, connections between said control surface and said control element whereby said surface is movable by the control element upon change in the direction of pull of the towline, and means for resiliently holding said control surface in predetermined position and for dampening movement of said surface from said position by the control element, said resilient and dampening means comprising a resilient tension element acting on said angularly movable portion of said control element and in line therewith when in neutral position.

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