Dec. 9, 1947. R. E. DOWD 2,432,297

FLYING WING

Filed Nov. 16, 1944

Fig. 1.

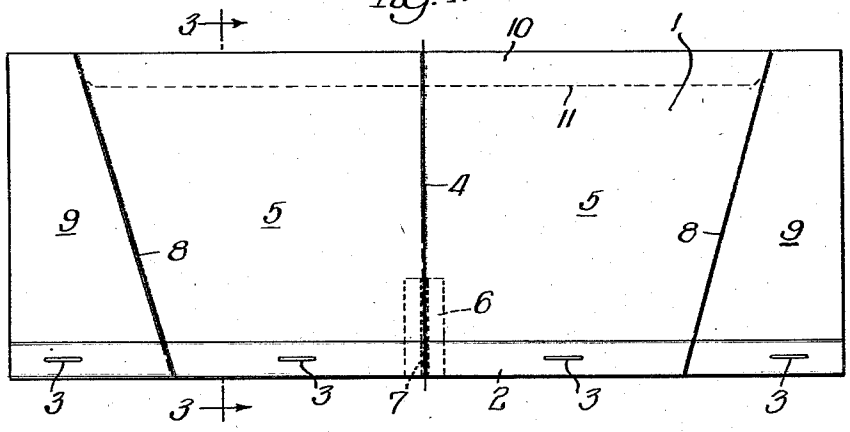


Fig. 2.

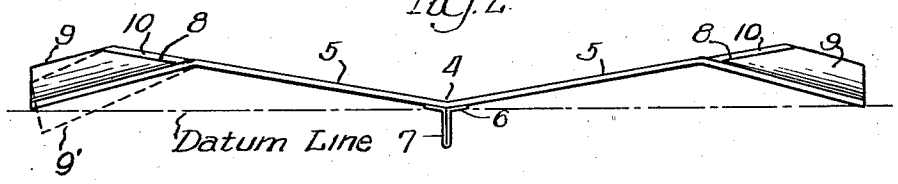


Fig. 3.

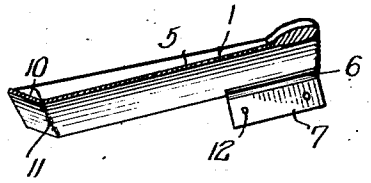


Fig. 4.

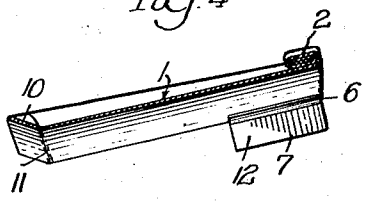


Fig. 5.

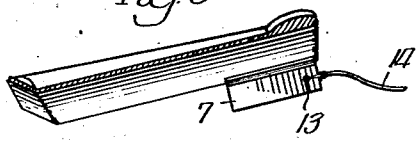
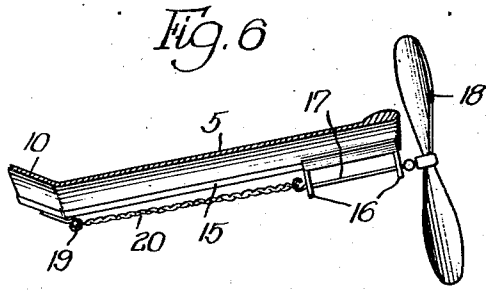


Fig. 6.



INVENTOR.
Raymond E. Dowd.
BY George H. Simmons
Atty

Patented Dec. 9, 1947

2,432,297

UNITED STATES PATENT OFFICE

2,432,297

FLYING WING

Raymond E. Dowd, Chicago, Ill.

Application November 16, 1944, Serial No. 563,707

6 Claims. (Cl. 244—35)

1

This invention relates to tailless airplanes or flying wings that may be either gliders or power driven types, and has for its principal object the provision of a new and improved device of this kind.

It is a main object of the invention to provide a flying wing that is highly maneuverable yet possesses great inherent stability.

Another object of the invention is to provide lateral stability and control in a flying wing thru the use of a combination of dihedrals and negative wing tip sections converging toward a point located forwardly of the wing.

Still another object of the invention is to provide a flying wing that may be made cheaply, without sacrificing inherent stability or maneuverability.

Still another object of the invention is to provide a flying wing incorporating the teachings of the invention, that can be used as a toy or an advertising novelty.

Further objects of the invention not specifically mentioned here will be apparent from the detailed description and claims which follow, reference being made to the accompanying drawings in which a preferred embodiment of the invention is shown by way of example in which:

Figure 1 is a plain view of the flying wing;

Figure 2 is an elevational view from the front or leading edge of the wing;

Figure 3 is a cross sectional view taken substantially along the line 3—3 of Figure 1, looking in the direction of the arrows;

Figure 4 is a view similar to Figure 3, showing a modified form of construction;

Figure 5 is a view similar to Figure 3, showing a kite string attached;

Figure 6 is a view similar to Figure 3, with a rubber band driven propeller attached.

Tailless airplanes, or flying wings as they are usually called, have been the subject of much prior consideration, of which I am aware, both for use as load carrying airplanes and gliders, and also as toys. Such prior art developments have employed laterally upswept wings, or dihedrals—as they are usually called—to achieve greater stability, and have also employed negative wing tip sections usually combined with radically swept back wings for this purpose. The line of attachment of the negative wing tip section to the center section of the wing has been parallel to the median line of the ship in these prior art developments. Invariably vertical control surfaces, both fixed and adjustable, have been employed to produce lateral stability and

2

control, and the use of such surfaces has prevented the device from being truly a flying wing.

The present invention provides a flying wing in which lateral stability and control are achieved in the wing itself rather than thru the use of vertical stabilizers and control surfaces. This feature is accomplished by altering the lines of attachment of the negative wing tip sections to the main wing so that those lines converge toward a point along the median line of the ship approximately three or more chord lengths ahead of the leading edge of the wing. The angle of convergence so formed places the wing tip sections in an attitude which imparts great inherent stability to the ship without appreciably affecting the efficiency of the wing as a unit.

In its preferred form the wing is loaded at its leading edge, either thru the location of power equipment or otherwise, to bring the center of gravity of the device slightly in advance of the usual center of pressure location of the wing. The airfoil is preferably shaped and ballasted so that the center of pressure and center of gravity coincide at a point approximately 27 to 30 per cent of the distance from the leading tip to the trailing edge and on the median line extending between these edges.

The simplest form to which the present invention may be applied is a toy glider which may be formed from a sheet of fairly stiff fibrous material such as 24-pound bond paper and when so formed and properly adjusted, a highly efficient ship having great inherent stability and high maneuverability is produced and the toy is capable of executing many maneuvers heretofore impossible in toys of this kind. The device may also be produced from molded pulp or may be made from several sheets of fibrous material or plywood as desired. Power may be applied to a propeller thru the usual rubber strands motor or in the case of a larger wing, by a miniature gasoline engine and the ship flown the same as a full size ship except for control from within the ship.

Referring now to the drawings in more detail, wherein the invention is illustrated in connection with a flying toy, by way of example, it will be seen in the Figures 1, 2 and 3, in its simplest form the toy may consist of a sheet of a fairly heavy tough fibrous material such as a twenty-four pound bond folded lengthwise on one of its edges over and over on itself until approximately one-half of the sheet 1 is disposed in the fold 2 Figure 4, which folded-over portion may be secured to the main section of the sheet in any preferred manner, such as by wire staples 3,

or by gluing. While stapling or gluing is preferable, it is not necessary, as the stiffness of the stock will hold the folds in place fairly well and an unfastened fold may be used. This folded-over portion forms the front or leading edge of the wing and loads the wing to insure the desired center of gravity location of the wing will coincide with the center of pressure of the wing in normal flight. As shown, the wing is rectangular in shape, which is preferable when formed from sheet stock as described. However, if desired, the chord of the wing may be decreased toward tip sections to form the usual tapered wing, and the wing tips may be suitably rounded.

The wing so formed is bent on its median line 4 so that the sections 5 of the wing adjacent thereto extend upwardly at an angle of approximately ten degrees from a horizontal plane thru the median line 4, giving this portion of the wing a positive dihedral. At the point on the wing indicated by reference 8 the positive dihedral changes to a negative dihedral as well as negative angle of incidence occasioned by the angularity of the line of change reference 8.

A reinforcing and launching tab 6 may be secured to the under side of the wing along the median line 4, and at the leading edge of the wing in any preferred manner—such as by gluing. This tab may carry a downwardly depending portion 7, which is employed in launching the wing, as will presently appear. The tab has no aerodynamic function since the wing flies equally as well without this tab.

The wing sections 5 are bent downwardly along lines 8, which lines 8 if extended would intersect the median line 4 extended, at a point three or more chord lengths ahead of the leading edge of the wing—that is, point of intersection is preferably three or more times as far from the leading edge of the wing as is the trailing edge of the wing. The negative angle wing tip sections 9 so formed terminate approximately on the horizontal plane thru the median line 4 at the leading edge of the wing. These wing tip sections 9 converging at a point ahead of the wing and at the same time below the median line of the wing at the leading edge, produce no appreciable loss of lifting efficiency of the wing but do increase the maneuverability and inherent stability of the wing.

While the location of the point of convergence of the tip sections at three or more chord lengths ahead of the wing is preferable, it may be varied within the teachings of the invention. If the distance is increased the sharpness of the angle is decreased and the amount of stability and control obtained thru the wing tips is decreased. If the distance is decreased the stability and control obtained is increased, but the drag of the sections is increased and the efficiency of the wing impaired. The three chord minimum distance has been found to strike a desirable balance between these effects.

As shown in the drawings, the area of the wing tip sections is approximately one-half the area of the main wing, a proportion which has been found to be satisfactory. A greater or lesser proportion of the total wing area may be incorporated in the wing tips within the teachings of the invention. Generally speaking, the greater the wing tip area the smaller the angle of convergence necessary to produce a given effect and with a larger tip area the point of convergence may be moved farther ahead of the wing without loss of lateral stability and control.

The trailing edge 10 of the wing is preferably

bent slightly upward along a line 11 that is parallel to the leading edge of the wing and extends thru the wing sections 5. In the drawings the angle of upward bend of the trailing edge 10 has been exaggerated somewhat for clarity. This angle may be varied to increase or decrease the downward thrust on the trailing edge of the wing produced by the flow of air on section 10 and thereby decrease or increase the angle of glide of the wing. This same means is employed to bring the center of pressure into coincidence with the center of gravity under normal flight conditions.

When launched in a substantially horizontal position the properly adjusted wing has a small angle of attack, possibly one or two degrees, and will descend at a fairly flat angle of glide so that the wing travels a considerable distance before landing. As is well understood by those in the art that the center of pressure in a wing of this type usually is approximately one-third of the distance back from the leading edge, and with the center of gravity located slightly forwardly of this usual center of pressure, the ship is nose heavy and has a steep angle of glide. This tendency is corrected by the downward thrust on the trailing edge of the wing occasioned by the force of air on section 10, which brings the center of pressure into coincidence with the center of gravity as well as improving the longitudinal stability. By proper adjustment of the angle of this section 10 this force can be controlled and the angle of glide can be set to any desired value.

With the wing properly formed and adjusted as above the center of gravity and the center of pressure of the wing both fall on the median line and when released in a horizontal position, the wing glides in a straight line. If it fails to do this, the negative angle of one of the tip sections 9 can be increased to compensate for any unbalance in the structure and this adjustment varied until the wing glides in a straight line.

Figures 1 and 2 show the wing symmetrical in all respects but it should be pointed out that a convenient directional control can be exercised by the simple expedient of changing the angle of the outer sections of the wing as indicated by the dotted lines 9' Figure 2. The increase of the angle decreases the lift and increases the drag on the side of the change thereby causing a turning effect for the whole wing without the use of conventional ailerons or rudders. Likewise if one tip angle is increased and the other decreased the effect is more pronounced.

When properly adjusted, if the wing is released at an upward angle and with considerable force, it will fly in a vertical loop until its speed is reduced to the point at which it will glide in a straight line. When properly adjusted and launched, the wing will make a large loop and then a smaller loop before straightening out into its straight angle glide. Launching for such maneuvers can best be accomplished by the use of a catapult such as—for example—the catapult shown in my prior Patent 1,652,519, issued December 13, 1927.

When properly adjusted and launched in vertical or steep bank, the wing will glide in a circular path returning to a point at or near the point of launching. When launched with a catapult, the wing may negotiate several complete circles before losing its flying speed. As will be apparent to one skilled in the art, the radius of the circle thru which the wing thus flies can be adjusted by varying the angle of upturn of the trailing edge 10 of the wing.

If desired, the launching tab 7 may be perforated at a point 12, which is coincident with or very slightly in advance of the center of gravity of the wing and a thread or string attached to the wing thru its perforation. The string may be attached to a rod or pole such as, for example, a fishing pole, which is moved to pull the wing thru the air, preferably in a generally circular path. With a little practice in manipulation, the wing can be made to execute a large variety of dives and glides under these conditions.

The tab 7 may also be perforated at a point 13, Figure 5, which is near the leading edge of the wing and well in advance of the center of pressure. A kite string 14 may be attached at this point and with the wing in proper adjustment, it can be flown as a kite in stable flight without loading the trailing edge with a conventional tail as has been necessary heretofore in models of this kind to stabilize the flight of the kite. The inherent stability of the properly adjusted wing is so great that the use of a tail has been found unnecessary in quiet air. However, under conditions of a gusty or highly variable wind velocity a drag line extending rearwardly from the trailing edge prevents the wing from gliding upwind during lulls in the wind. This drag line serves to decrease the gliding angle and causes the wing to settle rather than to advance upwind.

While the flying wing involving the teachings of the present invention can be formed by rolling up a sheet of paper in the manner just described, the model so formed can be used repeatedly before the folds become so weakened that the wing will quickly get out of adjustment, it is not necessary that the wing be constructed in this manner. As will be shown in Figure 3, the wing may be formed of a fibrous material and stiffening along its leading edge by greater accumulation of that material at this point. Fibrous material may be in the form of a sheet of light cardboard and the accumulations formed by pasting or gluing an additional piece of cardboard along the leading edge or the fibrous material may be pulp and the wing molded therefrom in the usual manner. The molded pulp wing, in which the wing tip sections and trailing edge section 10 are molded into the model, should stand more usage than when a wing is formed of paper in the foregoing manner. The teachings of the invention may also be applied to conventionally constructed wings having spars, beam ribs, etc., located within the airfoil, this type of construction being preferable in the larger power driven models.

In Figure 6 I have illustrated the manner in which power may be applied to the wing hereinbefore described. The wing in this case will be shaped as before except for the launching tab 7 which will be replaced by a longer and stronger stiffening means 15, located on the underside of the wing at the median line. Adjacent the leading edge of the wing is a bearing 16, which carries the propeller shaft 17, to which is secured the propeller 18. Near the trailing edge of the wing, stiffening means 15 carries a hook 19 to which one end of a rubber strand 20 is secured, the other end being secured to the propeller shaft 17. The weight of the reinforcement at the leading edge of the wing is decreased since the propeller and shaft extending forwardly of the wing will provide sufficient ballast to bring the center of gravity into coincidence with the center of pressure of the wing. The angle of upward turn of the trailing section 10 of the wing can be varied so that when the airplane so formed is flown, it will fly at the desired angle. Because of the greater

stiffness of the molded pulp wing, preferably a wing to which power devices shown in Figure 6 are applied is formed in this manner. Power devices known to those skilled in the art may require larger wings than can be readily formed of pulp and the use of a wing constructed with ribs and spars covered with a skin is contemplated in such cases.

In the foregoing description, the principles of the invention have been applied to a model or toy wing. Such wings may be cheaply constructed for sale as a toy or advertising novelty. While the invention lends itself well to such use, it may also be applied to larger wings including full size airplanes and gliders and I am not to be limited by the illustration and description shown by way of example. The teachings of the invention produce a flying wing having great inherent stability, a high degree of maneuverability and by adjusting the angle of the wing tips and trailing edge, adequate control is obtained. In a full size ship, these adjustments can be made under the control of an operator within the ship while it is in flight.

Having thus complied with the statutes and shown and described a preferred embodiment of my invention, what I consider new and desire to have protected by Letters Patent is pointed out in the appended claims.

What is claimed is:

1. A flying wing substantially rectangular in plan form, a main central section of said wing of positive dihedral and embracing approximately two-thirds of the total surface area of the wing, and wing tips of negative dihedral rigidly fixed to said main section along lines converging toward a point substantially three chord lengths ahead of the wing.

2. A flying wing substantially rectangular in plan form, a main central section of said wing of positive dihedral and embracing approximately two-third of the total surface area of the wing, wing tips of negative dihedral rigidly fixed to said main section along lines converging toward a point substantially three chord lengths ahead of the leading edge of said wing, said leading edge in elevation rising from the central point of said main section in a wide angle V and said tip sections extending downwardly and outwardly from said main section and terminating in a horizontal plane through the center of said main section.

3. A flying wing substantially rectangular in plan form comprising, a main central section of said wing of positive dihedral and embracing approximately two-third of the total surface area of the wing, wing tips of negative dihedral rigidly fixed to said main section along lines converging toward a point substantially three chord lengths ahead of the leading edge of the wing, and an upturned trailing edge on said main section.

4. A flying wing substantially rectangular in plan form comprising, a main central section of said wing of positive dihedral and embracing approximately two-thirds of the total surface area of the wing, wing tips of negative dihedral rigidly fixed to said main section along lines converging toward a point substantially three chord lengths ahead of the leading edge of the wing, and means on the leading edges of said main and tip sections for stiffening the same.

5. A flying wing substantially rectangular in plan form comprising, a main central section of positive dihedral and embracing approximately

two-thirds of the total area of the wing, wing tip sections of negative dihedral having approximately one-third of the total area of the wing and rigidly fixed to the main sections along lines converging toward a point substantially three chord lengths ahead of the leading edge of the wing, means on the leading edge stiffening the main and tip sections thereof, said means being straight in plan form and extending from tip to tip of the wing, and an upturned trailing edge on the main section of said wing.

6. A flying wing substantially rectangular in plan form formed of fibrous material thick enough to retain its shape, comprising a main central section of positive dihedral and embracing approximately two-thirds of the total area of the wing, wing tip sections of negative dihedral having approximatley one-third of the total area of the wing and rigidly fixed to the main section along lines converging toward a point substantially three chord lengths ahead of the leading edge of the wing, an upturned trailing edge on said main section for controlling the wing in flight, and a launching tab secured to the underside of said main section along the median line thereof and adjacent the leading edge and depending therefrom, there being a perforation in said launching tab ahead of and below the center of gravity of the wing and through which a string may be attached to permit flying the wing as a kite.

RAYMOND E. DOWD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,154,487	Bonnell	Apr. 18, 1939
2,004,543	Warren	June 11, 1935
1,518,621	Wenk	Dec. 9, 1924
1,924,651	Richter	Aug. 29, 1933
1,768,878	Bauer	July 1, 1930

FOREIGN PATENTS

Number	Country	Date
495,880	France	July 15, 1919
24,682	Great Britain	1908
257,631	Germany	Mar. 28, 1913
368,911	Great Britain	Mar. 17, 1932