May 9, 1933. P. H. SPENCER 1,907,887

TOY AIRCRAFT

Filed Oct. 6, 1932

Fig. 1.

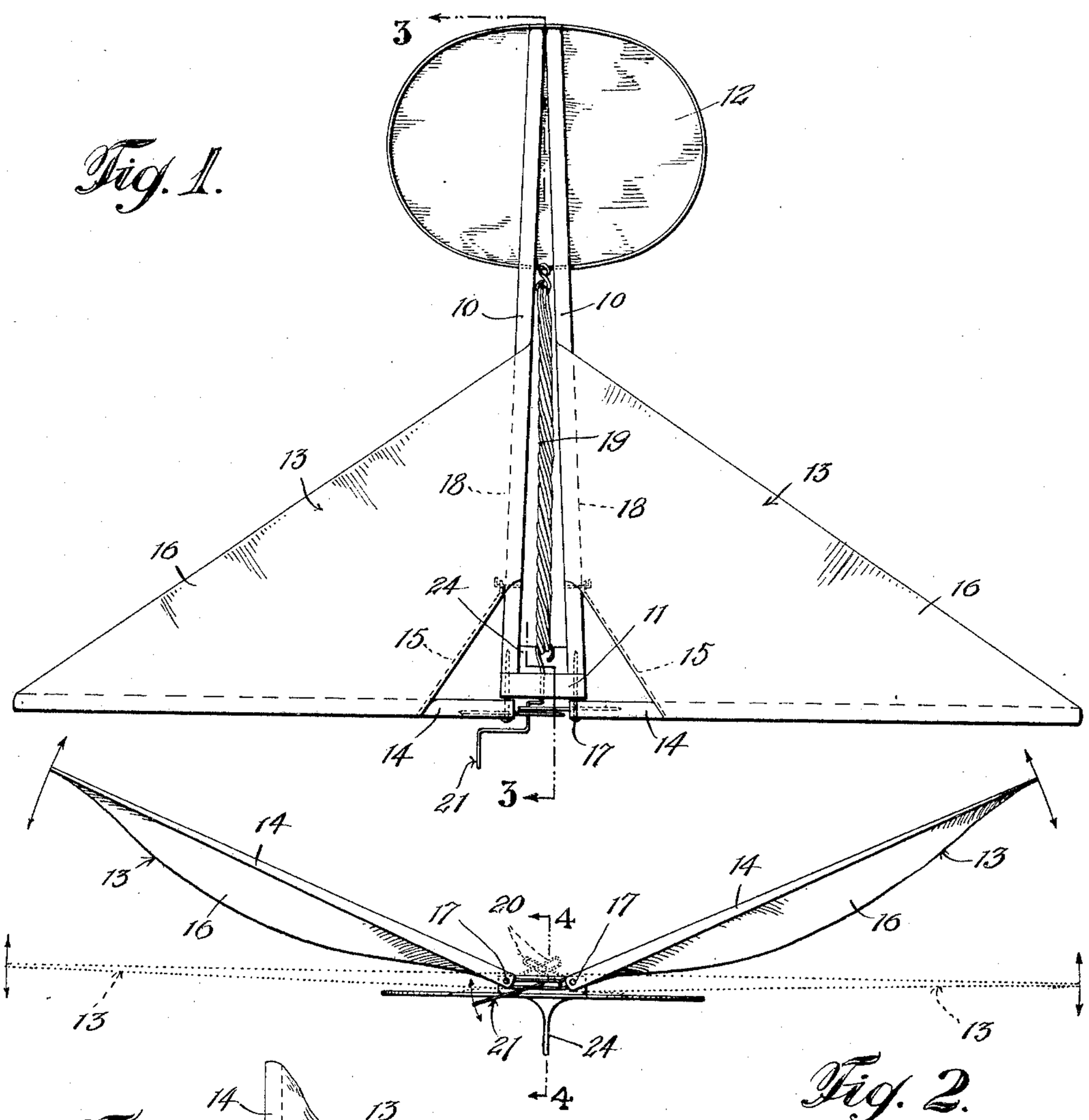

Fig. 2.

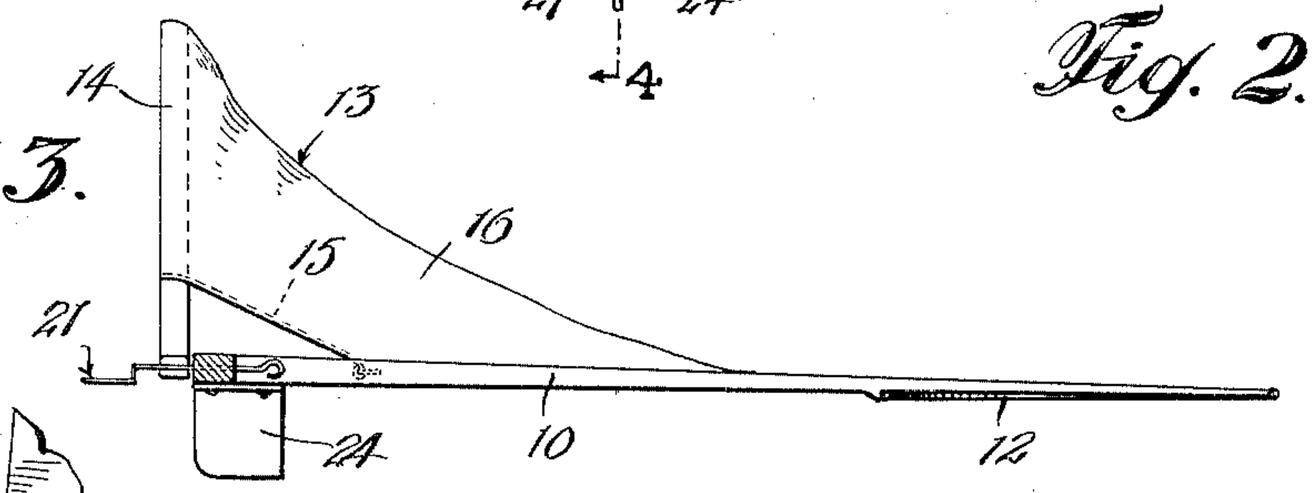

Fig. 3.

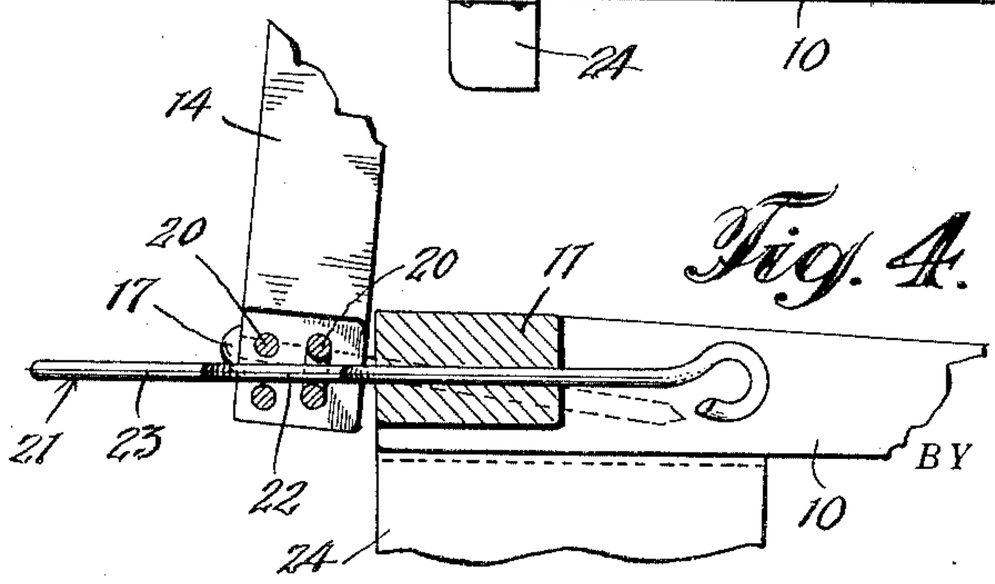

Fig. 4.

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TOY AIRCRAFT

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My invention relates to aircraft and more particularly to toy aircraft of the ornithopter or flapping wing type.

An object of the invention is to provide, in an ornithopter, a mechanically simple and efficient means for operating or oscillating the combined lifting and propelling surfaces or wings.

A further object of the invention is to so mount and construct the combined lifting and propelling surfaces as to induce, during oscillation of said surfaces, a lifting and propelling force greater per unit of area than has heretofore been obtained.

Other and further objects and advantages of the invention will be hereinafter set forth.

In the drawing, wherein like reference characters denote like or corresponding parts,

Fig. 1 is a plan view of the machine;

Fig. 2 is a front end elevation;

Fig. 3 is a longitudinal vertical sectional view on the line 3—3 of Fig. 1, and

Fig. 4 is a detail view of the mechanism for oscillating wings.

In the embodiment of the invention selected for illustration a toy ornithopter is shown. The principles are the same regardless of size and may be, if desired, embodied in a man carrying machine.

Referring to Fig. 1, the fuselage or body of the ornithopter is shown as comprising forwardly divergent longérons or body frame members 10—10 rigidly braced by a forwardly located cross-frame member 11. The longérons 10—10 taper to an edge at their rearward ends and have fastened against the underside thereof a fixed tail or horizontal stabilizing surface 12. To obtain proper balance or stabilization in a fore and aft direction, said surface 12 is given a slight negative incidence angle with respect to the fore and aft axis of the machine.

The combined lifting and propelling surfaces are designated as 13—13. Said surfaces extend out laterally from said body, one on either side thereof, and comprise each, a forward wing spar 14, a diagonal drag brace 15, and a suitable light weight strong flexible surfacing material 16. The wing spars 14 at their inner ends are pivotally fastened to the cross-frame member 11, the pivot axes 17 in each instance being preferably set at a noticeable positive angle for a purpose to be hereinafter more fully described.

The surfacing material 16, as indicated, is coextensive with the wing spars 14 except for a short distance at the inner end of each spar. Said material is fastened to the top surface of each spar and in plan tapers uniformly from root to tip. Along its inner or root edge said material is fastened to the body frame and is carried rearwardly to a point closely adjacent to the leading edge of the stabilizer 12. The line of attachment of said surfacing material with said body frame is designated, in each instance, as 18. Said lines of attachment constitute the respective rearwardly disposed hinge or pivot axes about which the wings or combined lifting and propelling surfaces oscillate during flight. To insure effective lift and forward thrust it is essential that the axes 17 and 18 be disposed in unaligned relation.

The mechanism for operating or oscillating the wings 13—13 consists of a rubber band 19 (or other motive power), over-lapping juxtaposed angular links 20—20, and a combined operating and winding crank shaft 21. The rubber band 19 is fastened at its forward end to the rear end of the crank shaft 21 and at its opposite end is fastened to the leading edge of the horizontal stabilizer 12. It (the band 16) lies entirely between the longérons 10—10 of the body frame, and as a result of its unwinding action when released, causes the crank shaft 21 to rotate so long as the energy stored in the band 16 is unspent. Said shaft 21 is journaled in the cross-frame member 11 so that its cranked end may operate or freely rotate in the space between the inner spar ends.

The wing spars 14 are provided at their inner ends each with one of the aforementioned links 20. Said links 20 over-lap (see Fig. 4) and have formed therein elongated slots thru which the operating throw of the crank shaft 21 extends. As said links are actuated by said crank shaft the wings are caused to oscillate simultaneously to induce thereby forward thrust and lift. In addition to the

operating crank, designated as 22, said crank shaft 21 has formed thereon, at its forward end, a second or winding crank throw 23 of a radius greater than that of the operating throw 22. Thus constructed, the winding loads, in a winding operation, are very materially reduced.

It will be seen from the above that the two combined lifting and propelling surfaces are each movable about two unaligned axes, i. e., axes making with respect to each other angles other than straight angles. When the axes indicated by the lines 18—18 are substantially parallel with the horizontal plane of the body axis, the axes 17—17 may be canted up or down. Such canting of the axes 17—17, due to the induced angular movement of the spars 14, cause a fore-shortening and lengthening between the tip of each spar and the rear extremity of the surfacing material, thereby giving a decided slackening and tightening effect to the surfacing material as the wings oscillate. The extent of the induced angular movement of said spars is limited by the degree of cant plus the degree of angularity accorded the operating links 20. By changing the axes of the spars from positive to negative, the slack in the surfacing material occurring when said spars are "up", can be made to occur when spars are "down". In either case, the desired combined propelling and lifting force is obtained. The spars, under all operating conditions are held, at their inboard ends, against untoward displacement by the drag braces 15 which move up and down with the wings. To the end that the mean dihedral of the wings 13—13 shall be positive rather than negative, it is preferred that the axes 17—17 be given a positive angular setting.

For the purpose of launching the machine by hand, as well as for the purpose of improving its directional stability and at the same time providing a skid for landing, a vertical keel or support 24 is provided. Said keel 24 preferably consists of a thin metal plate bent upon itself and fastened against the under side of the body frame at or near its forward end. In launching the machine, or in winding the rubber band, said keel may be grasped between the thumb and index finger of the hand of the operator and the machine thus firmly held. After winding, and while thus held, the operator can, if desired, extend the index finger beyond the forward end of the machine to act as a stop against which the operating crank, during that period of operation intervening between the completion of the winding operation and actual launching, is adapted to abut. After flight, said keel acts as a landing skid and at the same time prevents the operating crank from coming in contact with the landing surface or ground.

It will be noted further that the combined lifting and propelling surfaces are actuated on their respective axes and that the wing spars are limited in their vertical movement by the operating links 20—20. Said links have parallel and straight sides and thru the slots therein the crank throw 22 is carried. The operating mechanism, therefore, is extremely simple and comprises but three moving parts, to wit: the crank shaft, the wing spars, and the operating links thru which the operating crank is carried.

While I have described my invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art after understanding my invention, that various changes and modifications may be made therein without departing from the spirit or scope thereof. I aim in the appended claims to cover all such modifications and changes.

What is claimed is:

1. In aircraft, a body, oscillatable combined lifting and propelling surfaces extending laterally out from said body one each at opposite sides thereof, each of said surfaces having at its inner end longitudinally spaced separate unaligned axes of oscillation, and means for oscillating said surfaces.

2. In aircraft, a body, oscillatable combined lifting and propelling surfaces fastened to said body, said surfaces each having two axes of oscillation, one of said axes of oscillation making with the other of said axes of oscillation an angle other than a straight angle, and means for oscillating said surfaces.

3. In aircraft, a body, oscillatable combined lifting and propelling surfaces fastened to said body, said surfaces each having two axes of oscillation, one of said axes of oscillation paralleling the horizontal plane of the fore and aft axis of said body and the other of said axes of oscillation making with said first mentioned axis of oscillation an angle other than a straight angle, and means for oscillating said surfaces.

4. In aircraft, a body, oscillatable combined lifting and propelling surfaces fastened to said body, each of said surfaces including a main leading edge spar pivotally fastened at its inner end to said body and a sheet of flexible surfacing material fastened along its forward edge to said spar and along its inner edge to said body, said surfaces each having two unaligned axes of oscillation, one of said axes of oscillation extending along the line of connection of said surfacing material with said body and the other of said axes of oscillation defining the pivot axis of said spar, and means at the inner spar ends for oscillating said surfaces.

5. In aircraft, a body, oscillatable combined lifting and propelling surfaces fastened to said body, each of said surfaces including a

main leading edge spar and a sheet of flexible surfacing material, the surfacing material of each of said surfaces along its forward edge, being fastened to its associated spar, and along its inner edge, being fastened to said body, the line of attachment of said surfacing material to said body defining one axis of oscillation for said surface, a pivotal connection between said spar and said body at the inner end of said spar, said pivotal connection defining a second axis of oscillation for said surface out of alignment with said first mentioned axis of oscillation, and means for oscillating said surfaces.

6. In aircraft, a body, oscillatable combined lifting and propelling surfaces extending laterally out from said body, one each at opposite sides thereof, a main leading edge spar incorporated in the structure of each of said surfaces, each of said spars at its inner end having a pivot axis set at an angle to the fore and aft axis of said body, surfacing material for each of said surfaces fastened along its inner edge to said body and along its forward edge to said spar, said surfacing material being alternately slacked and tightened as said surface oscillates, and means for oscillating said surfaces.

7. In aircraft, a body, oscillatable combined lifting and propelling surfaces extending laterally out from said body, one each at opposite sides thereof, a main leading edge spar incorporated in the structure of each of said surfaces, surfacing material for each of said surfaces fastened along its inner edge to said body and along its forward edge to its associated spar, a drag brace for each surface fastened at its opposite ends to its associated spar and to each said body, said drag brace at its inner end having a pivotal connection with said body, and means at the inner spar ends for oscillating said spars and hence said surfaces.

8. In toy aircraft, a body, oscillatable combined lifting and propelling surfaces fastened to said body, one each at opposite sides thereof, a wing beam incorporated in the structure of each said surface, each said beam at its inner end being extended to provide at the forward end of said body an extension overlap, an operating crank extension formed upon said shaft, said extension being carried through both said beam extensions to operate both said surfaces simultaneously, and a winding crank extension formed upon the outer end of said operating crank extension, said winding crank extension having a radius of throw greater than said operating crank.

9. In aircraft, a body, an oscillatable combined lifting and propelling surface fastened to said body, and operating means for said surface comprising a source of power and a rotatable shaft, said shaft being coupled with said source of power and having at one side of its journal bearing a double throw crank extension, said throws being of unequal radii and providing for said surface and for said source of power an operating crank and a winding crank, respectively.

In testimony whereof I hereunto affix my signature.

PERCIVAL H. SPENCER.