Dec. 15, 1931. F. SMITH 1,836,406

FLYING MACHINE

Filed Feb. 15, 1930 4 Sheets-Sheet 1

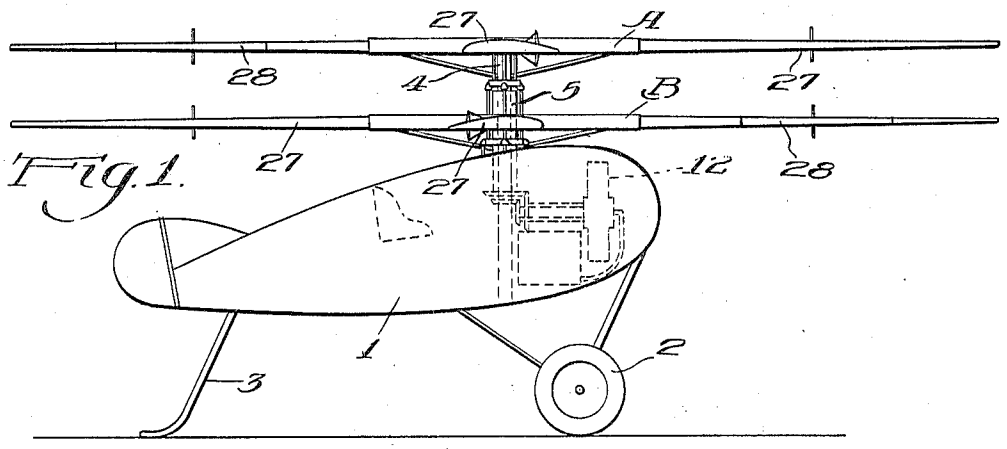


Fig. 1.

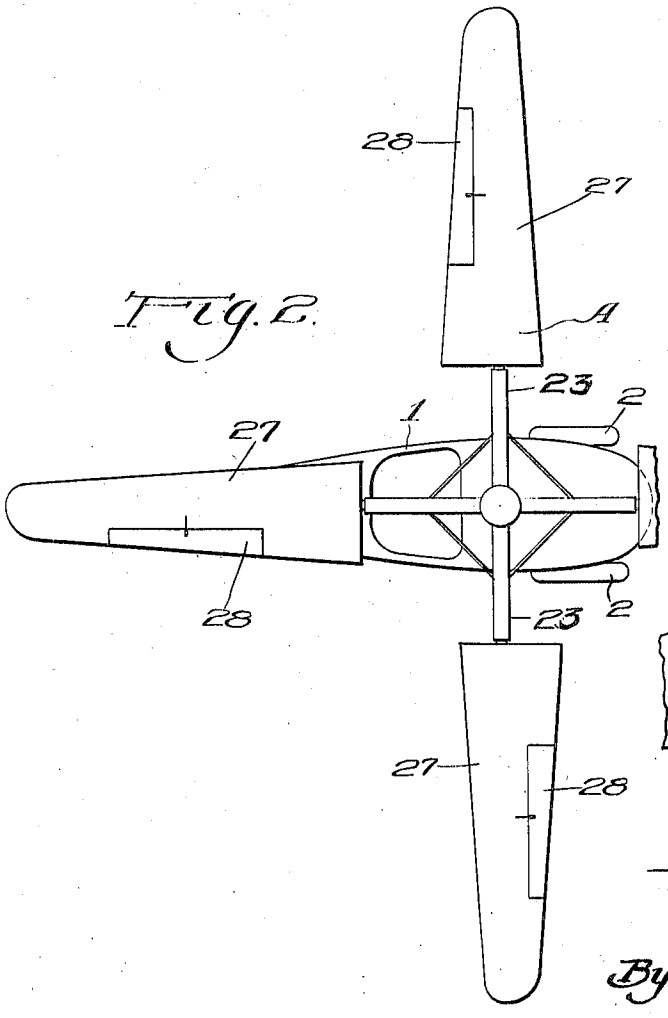


Fig. 2.

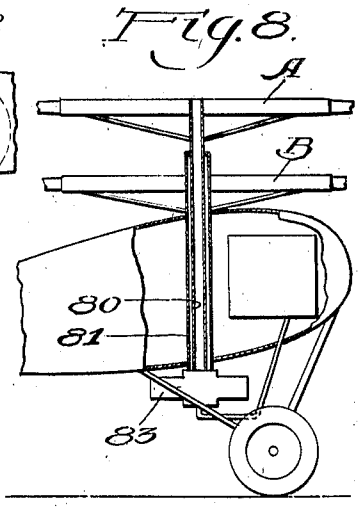


Fig. 8.

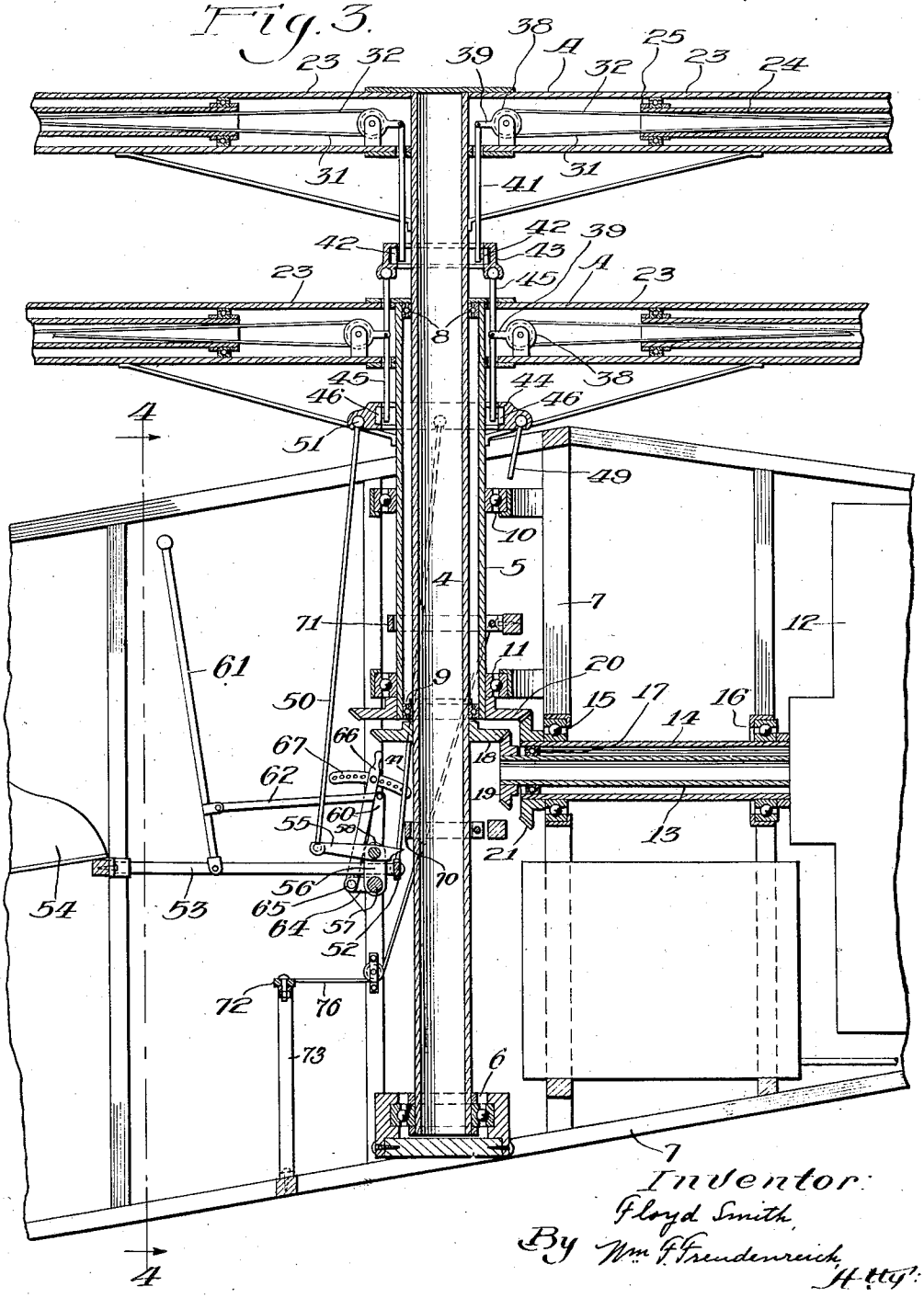
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Fig. 3.



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Fig. 4.

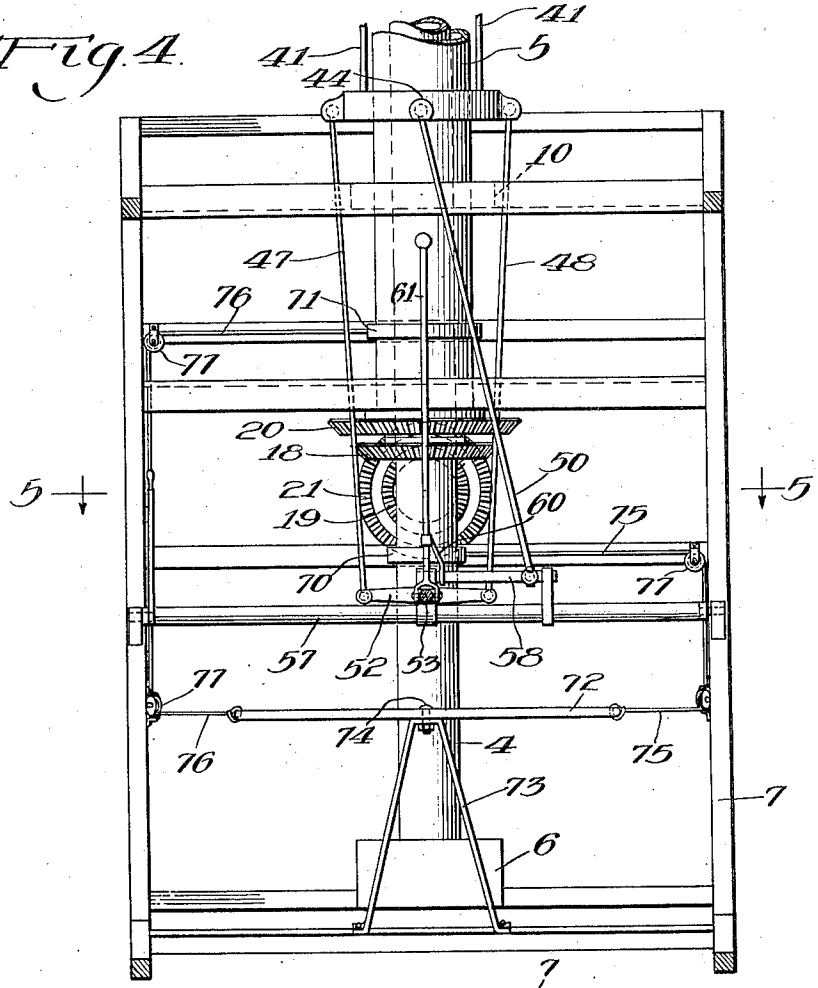
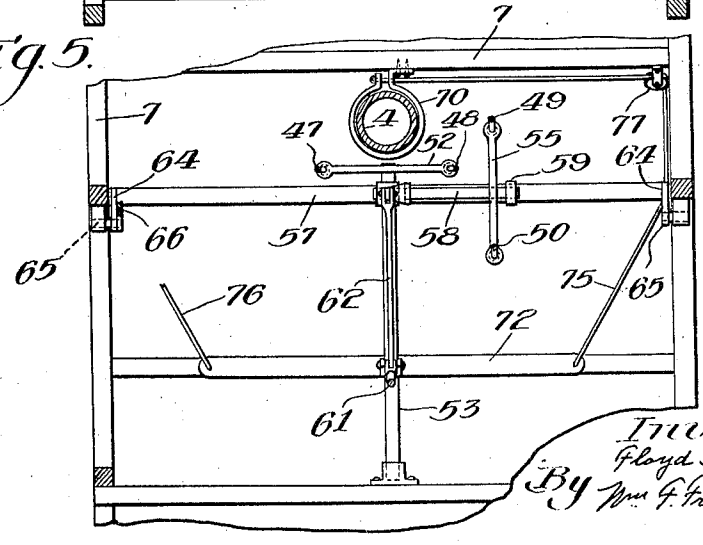


Fig. 5.



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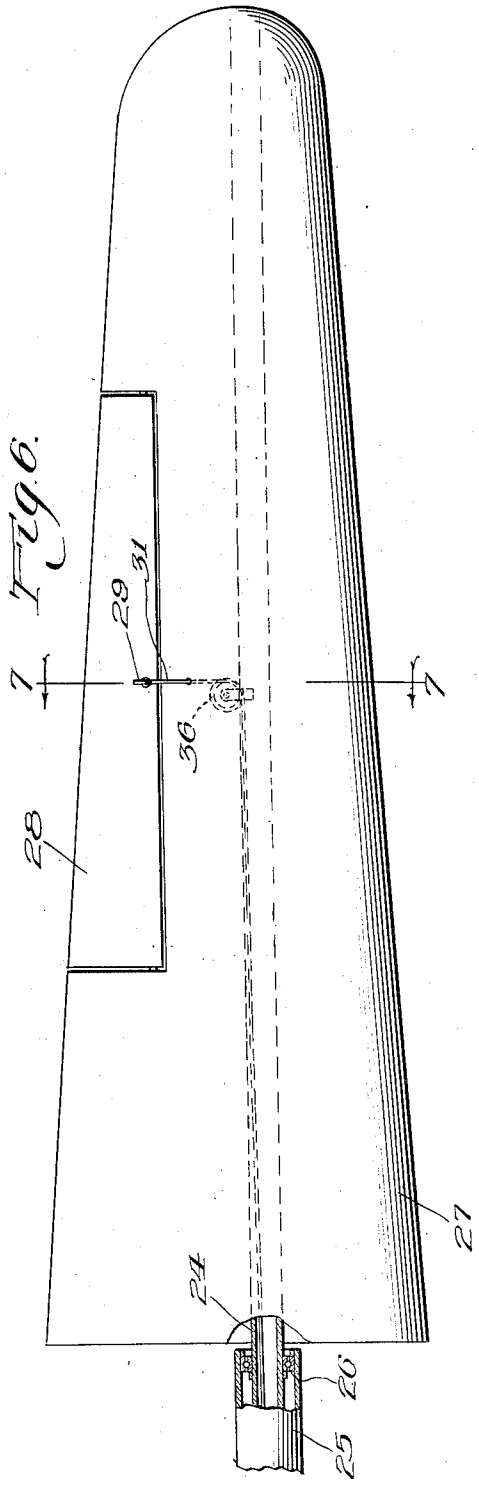


Fig. 6.

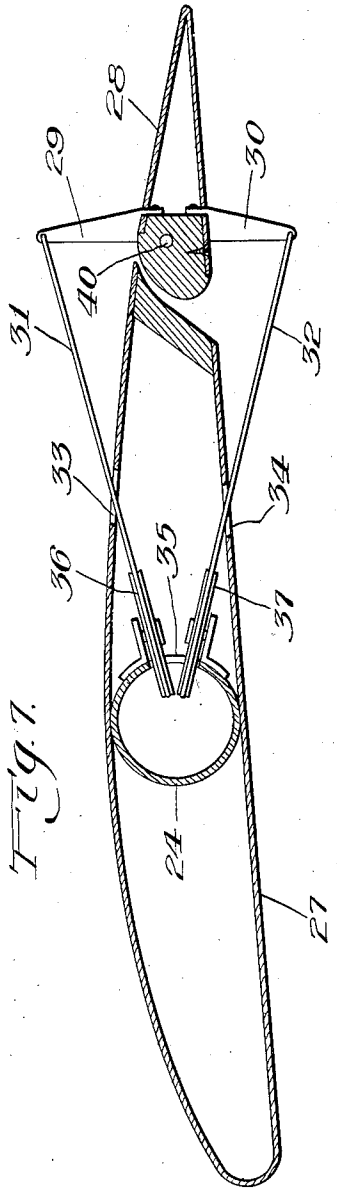


Fig. 7.

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UNITED STATES PATENT OFFICE

FLOYD SMITH, OF MORRISVILLE, PENNSYLVANIA

FLYING MACHINE

Application filed February 15, 1930. Serial No. 428,627.

The present invention relates to flying machines of the helicopter type and has for its object to produce a machine that will be efficient and safe in operation, possesses great stability and be easily maneuvered. Further objects are to produce a structure that is compact and strong and in which torque on the fuselage is eliminated.

In carrying out my invention, I employ two coaxial screws rotatable in opposite directions, each screw having large efficient balanced blades. These screws are driven respectively from the shaft and the casing of a motor of the type in which the shaft and the casing both revolve, but in opposite directions. Consequently great motor efficiency results; and, therefore, viewed in one of its aspects the present invention may be said to have for its object to produce a flying machine possessing great motor efficiency.

The various features of novelty whereby my invention is characterized will hereinafter be pointed out with particularity in the claims; but, for a full understanding of my invention and of its objects and advantages, reference may be had to the following detailed description taken in connection with the accompanying drawings, wherein:—

Figure 1 is a side view of a machine constructed in accordance with the present invention; Fig. 2 is a top plan view, one of the aerofoils being broken away; Fig. 3 is a vertical longitudinal section, on a larger scale, through the axis of rotation of the screws, only fragments of a machine and screws being shown; Fig. 4 is a section taken on line 4—4 of Fig. 3; Fig. 5 is a section on line 5—5 of Fig. 4; Fig. 6 is a top plan view of one of the aerofoils or blades, on the same scale as Fig. 3, portions being broken away to show interior construction; Fig. 7 is a section on line 7—7 of Fig. 6, on a still larger scale; and Fig. 8 is a view partly in side elevation and partly in section of a fragment of the machine containing a modification.

Referring to the first seven figures of the drawings, 1 represents a fuselage of any usual or suitable construction, supported at the front end by wheels 2, and at the rear end by a skid 3.

Arranged within the fuselage or body and rising above the same are two telescoped shafts 4 and 5, preferably of tubular construction. The inner shaft extends upwardly beyond the upper end of the other. On the upper end of each shaft, as will hereinafter be explained, is a screw. In the arrangement shown, the inner shaft 4 extends down to a point near the bottom of the fuselage where it is provided with a suitable bearing 6 supported from the framework 7 of the body. The outer shaft 5 is comparatively short, and there are suitable bearings 8 and 9 between the upper and lower ends of the same and the inner shaft. The shaft 5 is provided with two bearings 10 and 11, spaced apart along the same, and also carried by the frame structure. This arrangement of bearings permits the shafts to rotate freely independently of each other and be held against endwise movements relatively to each other or to the fuselage.

In front of the mast-like shafts is a motor whose casing 12 and shaft 13 both revolve, but in opposite directions. The casing is shown as having a long tubular extension 14 surrounding the motor shaft and journalled in suitable bearings 15 and 16 mounted on the fuselage frame. There is also a bearing 17 between the motor shaft and the tubular part 14 near their free ends. The upright shafts are driven from the motor shaft 13 and the tubular member 14 in any suitable way. In the arrangement shown, the inner vertical shaft 4 has fixed thereto a bevel gear 18 meshing with a complementary gear 19 fixed to the motor shaft. Similarly, a bevel gear 20, fixed to the lower end of the shaft 5, meshes with a complementary gear 21 fixed to the tubular member 14. Consequently, when the motor is running and the motor shaft and the member 14 are revolving in opposite directions, the upright shafts will also be revolved in opposite directions, so that the screws on the upright shafts will be turning in opposite directions and exert a balancing effect on each other to eliminate torsional stresses on the framework.

The screws at the upper ends of the upright shafts may be alike, so that a descrip-

tion of one will suffice for both. In the drawings the upper screw, mounted on the inner of the two upright shafts, is indicated as a whole by the reference letter A, whereas the lower screw, carried by the other upright shaft, is indicated as a whole by the reference letter B. Each screw has a central hub-like part from which radiate tubular spokes or arms 23, four such arms being shown. Small tubular spars 24 are arranged within these arms and project a considerable distance beyond the same. In the arrangement shown, there are two bearings, 25 and 26, between each spar and the surrounding portion of the hub structure, to permit the spar to turn freely while held against lengthwise movement. On the outer end of each spar is fixed a long narrow aerofoil or blade 27, the long axis of the spar passing near the center of pressure on the aerofoil or blade. The aerofoils are preferably hollow, as best shown in Fig. 7, the depth of the chamber therein being equal to the external diameters of the supporting spars; whereby the spars will fit into the aerofoils and be enclosed thereby.

It will thus be seen that the aerofoils or blades are free to turn about the long axes of the spars, that is, about axes radial to the axis of rotation of the screws as a whole.

A portion of the trailing end of each aerofoil, as indicated at 28, is hinged thereto for swinging movements about an axis parallel to the axis of the corresponding spar. By varying the angle between each hinged portion and the remainder of the aerofoil, the angle at which the aerofoil sets itself when the screw is rotating, namely, the angle of attack, also varies. As best shown in Fig. 7, the meeting edges of the body portion of each aerofoil and its trailing portion are shaped to produce between the same an air passage narrow at the top and terminating in a wide, flaring mouth on the under side of the aerofoil. Each higed portion is provided with rigid arms or short masts, 29 and 30, which respectively project upwardly and downwardly from the same near the hinge axis 40. Two cables, 31 and 32, are connected to the free ends of the said arms or masts and are carried through openings, 33 and 34, in the wing into the interior of the latter. The spar is also provided with an opening 35. At opposite sides of the opening 35 are placed sheaves 36 and 37 which extend through the same into the interior of the spar. The cables pass around the sheaves and into the interior of the spar along which they are carried, crossing each other, to an oscillatory part 38 within the hub of the screw. The part 38 may conveniently be a wheel or disc to diametrically opposed points on which the ends of the cables are fixed. By turning the wheel in one direction, the hinged portion of the aerofoil is swung up and, upon turning the wheel in the other direction, the hinged portion is swung down. The wheel has a radial arm 39 by means of which it may be turned.

It will be seen that by providing suitable means acting on all of the arms 39 the hinged portions of the aerofoils may be caused to stand at any desired angle to the main portions of the aerofoils. Furthermore, if the controlling means be so arranged that whenever an aerofoil points forward or backward or to either side, its hinged portion is raised or lowered and the hinged portion on the opposite aerofoil is lowered or raised, at the same time, the angle of attack of each aerofoil may be increased or decreased whenever it reaches its forward or rearward position, or a position of either side, whereas the angle of attack of the opposite aerofoil will be decreased or increased, thus making it possible to obtain great stability. I have shown a simple controlling mechanism for accomplishing these results. To the free end of each arm 39 in the upper screw is attached the upper end of a depending connecting rod 41. On the lower end of each connecting rod is a wheel 42 journalled to revolve about a transverse axis. These wheels are engaged with a circular track 43 which, as shown, is channel-shaped in cross-section, with the open side of the channel directed toward the center. Consequently the connecting rods and the track are interlocked so that they cannot be separated from each other; but, if the track is held stationary, the wheels may run along the same while the upper screw is turning. It will be seen that a simple up and down movement of the track shifts all of the hinged sections of the aerofoils in the same direction and to the same extent. If the track be tilted, so as to raise it toward the front and depress it toward the rear, the wheels will rise and fall as they run along the track, causing the hinged portion of each aerofoil to be raised as the aerofoil points toward the front, and to be lowered when the aerofoil points toward the rear. Similarly a tilting of the track in the opposite direction will have the opposite effect. Also, if the track be tilted so as to raise it at either side, the angle of attack of each aerofoil may be increased when it reaches either side and be decreased when it reaches the opposite side. The track 43 is connected to a similar track 44 surrounding the upright shafts below the screw B, by means of connecting rods 45. The connecting rods 45 have on their lower ends wheels 46 interlocked with the track 44. Each of the connecting rods 45 serves also as an actuator for the cables in the screw B by being connected at a point between its ends to one of the arms 39 in that screw. When the track 44 is raised or lowered, or is tilted, it produces a corresponding movement in the upper track, so that similar ad-

justments are made in both screws by properly manipulating the lower circular track.

The lower circular track is supported on the upper ends of four rods 47, 48, 49 and 50. The connections between these rods and the track are preferably in the form of universal joints, as indicated at 51. The rods are connected at their lower ends to rock devices by means of which they may be raised and lowered. In the arrangement shown, the lower ends of the rods 47 and 48 are connected to the opposite ends of a rocker arm 52 fixed at the middle to the front end of a shaft 53 extending longitudinally of the fuselage just in front of the operator's seat 54. The lower ends of the rods 49 and 50 are connected to the opposite ends of a rocker arm 55 arranged and movable in a plane at right angles to the plane in which the rocker arm 52 rocks. The forward end of the shaft 53 is supported by and rotatable in a bearing 56 carried by a transverse rod or bar 57. The rocker arm 55 is fixed midway between its ends to a short shaft 58 lying above and parallel with the bar 57 and rotatable in suitable bearings 59 on the latter. The shaft 58 has fixed thereto an upwardly projecting arm 60. A controlling lever or handle 61 is hinged to the shaft 53 so as to be capable of being swung forward and backward without affecting the shaft whereas, when the handle or lever is moved toward the right or toward the left it turns the shaft 53. A link 62 connects the handle or lever 61 with the upper end of the arm 60.

It will thus be seen that if the lever 61 is moved forward it swings the rocker arm 55 so as to raise the rear end and lower the forward end; thereby raising the rear side of the track 44 and lowering the front side. If the handle or lever is pulled toward the rear the rear side of the track is drawn down and the front side pushed up. If the lever is swung toward the right, the shaft 53 turning with it, the left hand side of the rocker arm 52 is raised and the right hand side lowered; thereby raising the left hand side of the track 44 and lowering the right hand side. Similarly, if the lever is swung toward the left, the track is tilted so that its right hand side is higher than the left hand side. As heretofore explained, the track 43 moves in unison with the lower track so that, by means of the single lever 61, the angles of attack of the aerofoils of both screws may be caused to be automatically varied at predetermined points in each revolution of the screws.

When the controlling handle or lever is in its neutral position both tracks are coaxial with the two upright shafts and the trailing portions of the aerofoils all lie at the same angle. In order to vary what may be termed the normal angle between each aerofoil and its trailing section, it is only necessary to raise or lower the cross bar 57 which serves as the actual support for the two rocker arms 52 and 55. This can conveniently be accomplished by mounting the bar 57 between the free ends of a pair of short arms 64 arranged at the sides of the fuselage, and pivotally connected at their other ends, as indicated at 65, to the framework. Fixed to one of the arms 64, or otherwise associated therewith so that they must move in unison with each other, is an upwardly extending lever or handle 66 within reach of the operator of the machine. Assuming that the arms 64 extend forward from their hinge points when the parts are in what may be termed normal positions, it will be seen that a forward movement of the lever 66 will depress the bar 57, and therefore cause the two circular tracks to be drawn down. On the other hand, if this lever or handle is pulled back, the bar 57 is lifted, thus raising the two circular tracks. Suitable means, such as a notched segment 67, may be associated with the lever 66 to lock the latter in any position into which it may be brought. Consequently the operator may, by simply manipulating the lever 66, control the angle of attack of all of the blades or aerofoils, at will, for fast climbing, dropping, or for slowing up upon landing.

The machine may be caused to turn to the right or left by varying the relation between the actual speeds of rotation of the two screws, thereby disturbing the balance against a turning movement maintained by the equal and opposite thrusts of the two similar screws revolving at the same actual speeds in opposite directions. This can readily be accomplished by checking the speed of rotation of the motor shaft and permitting the motor casing to revolve more rapidly, or vice versa. In the arrangement shown this result is accomplished by two brake devices, one on the inner upright shaft and the other on the outer shaft. These brake devices may be in the form of simple bands 70 and 71, surrounding the respective shafts and normally loose thereon. When either band is tightened upon its shaft, the speed of rotation of the latter is checked. In the form of brake illustrated, one end of each band is fixed to the frame structure of the machine, and the other is free. When the free end of either band is drawn toward the anchored end the band is tightened on the corresponding shaft. In order to make the control of these brake devices simple, I provide a rudder bar 72 below and in front of the operator's seat in a position to serve as a rest for the feet of the operator. This bar extends transversely of the machine and is supported midway between its ends upon a pedestal 73; a vertical pivot pin 74 connecting the bar and the pedestal so that the operator may push either end of the bar forward by applying pressure with the proper foot. Cables 75 and 76 ex-

tend from the two ends of the rudder bar to the free ends of the brake bands 70 and 71, respectively. These cables extend from the brake bands over to the sides of the fuselage and then down into the plane of the rudder bar; passing over suitable guides which may be in the form of pulleys 77. When one end of the bar is pushed forward, the other end pulls back on the cable attached thereto and tightens the corresponding brake. Therefore, either screw may be slowed down relatively to the other by a simple pressure of a foot whenever it is desired to turn or move laterally in one direction or the other.

When the machine is resting on level ground, with the axis of rotation of the screws vertical, the longitudinal axis of the fuselage is inclined downwardly and rearwardly so as to make an angle of about ten degrees with the horizontal. In flight, upon operating the stick or main controlling lever forward until the fuselage is level, the axis of rotation of the screws will be inclined in the forward direction at an angle of about ten degrees to the vertical, thereby creating a forward thrust.

In the event that the motor stops with the hinge portions of the aerofoils, or elevators, set at a small angle for cruising, the blades or aerofoils will automatically incline forwardly or downwardly as the machine begins to descend; thus sustaining the machine so as to permit it to descend at a safe speed. The speed of descent may be decreased by setting the lever 66, which determines the angle of attack, to reduce the angle of attack of all of the blades or aerofoils to an efficient gliding angle.

Instead of placing the motor in the front end of the fuselage, it may be placed below and coaxial with the upright shafts; such an arrangement being shown in Fig. 8 in which the inner of the two telescoped upright shafts 80 is a continuation of the motor shaft or, at least, is coaxial with the latter; whereas the outer upright shaft 81 extends down to and is driven by the motor casing 83.

While I have illustrated and described with particularity only a single preferred form of my invention, with a slight modification, I do not desire to be limited to the exact structural details thus illustrated and described; but intend to cover all forms and arrangements which come within the definitions of my invention constituting the appended claims.

I claim:—

1. In a flying machine, two telescoped upright shafts the inner of which extends upwardly beyond the upper end of the outer shaft, radial arms carried by the upper ends of said shafts, aerofoils mounted on said arms so as to be capable of swinging thereon about axes radial to said shafts and near the center of pressure of the aerofoils, means to revolve said shafts in opposite directions, trailing portions of said aerofoils being hinged thereto, means to bring said trailing portions at any desired angle to the main bodies of the corresponding aerofoils, and means for causing each of said trailing portions to shift its position and increase said angle when reaching a predetermined point in its rotation about the long axis of said shafts and to shift its position and decrease said angle upon reaching a diametrically opposite point.

2. In a flying machine, a rotatable screw comprising a series of radial aerofoils mounted so as to be capable of swinging about radial axes passing through the same, trailing portions of said aerofoils being hinged thereto, devices rotatable with the screw for shifting the positions of said hinged portions, a nonrotatable circular track coaxial with the screw, cooperating elements on said devices and said track to actuate said devices when said track is moved from one plane to another, and mechanism for bodily raising and lowering the track and for tilting it in two directions at right angles to each other.

3. In a flying machine, a rotatable screw comprising a series of radial aerofoils mounted so as to be capable of swinging about radial axes passing through the same, trailing portions of said aerofoils being hinged thereto, devices rotatable with the screw for shifting the positions of said hinged portions, an actuating member for said devices consisting of a nonrotatable circular track, coaxial with the axis of rotation of the screw, elements on said devices interlocked with said track to permit them to run along the track and be held against separation from the track, a controlling lever, and connections between said lever and said track to tilt the latter in either of two directions transverse to each other.

4. In a flying machine, a rotatable screw comprising a series of radial aerofoils mounted so as to be capable of swinging about radial axes passing through the same, trailing portions of said aerofoils being hinged thereto, devices rotatable with the screw for shifting the positions of said hinged portions, an actuating member for said devices consisting of a nonrotatable circular track, coaxial with the axis of rotation of the screw, elements on said devices interlocked with said track to permit them to run along the track and be held against separation from the track, a support, means for shifting said support from and toward said track and locking it in any position into which it may be brought, mechanism interposed between said support and said ring for tilting said track in either of two directions transverse to each other, and a lever for operating said mechanism.

5. In a flying machine, two telescoped upright shafts the inner of which etxends upward beyond the other, means for revolving

said shafts in opposite directions, screws on the upper ends of said shafts comprising radial aerofoils mounted so as to be capable of swinging about radial axes passing through the same, a trailing portion of each aerofoil being hinged thereto, separated circular nonrotatable tracks surrounding said shafts, devices movable with said screws for shifting said trailing portions of the aerofoils including elements interlocked with said tracks so as to be movable along the same but held against separation therefrom, and means for simultaneously changing the positions of said tracks to actuate said devices.

6. In a flying machine, two telescoped upright shafts the inner of which extends upward beyond the other, means for revolving said shafts in opposite directions, screws on the upper ends of said shafts comprising radial areofoils mounted so as to be capable of swinging about radial axes passing through the same, a trailing portion of each aerofoil being hinged thereto, separated circular nonrotatable tracks surrounding said shafts, devices movable with said screws for shifting said trailing portions of the aerofoils including elements interlocked with said tracks so as to be movable along the same but held against separation therefrom, and means for simultaneously raising or lowering the tracks or simultaneously tilting them about either of two axes transverse to each other in order to vary the angle of attack of all of the aerofoils uniformly or cause the angle of attack of each aerofoil to be increased when it reaches a predetermined point in the rotation of the corresponding screw and to be decreased when it reaches a diametrically opposite point.

7. The combination with the body of a flying machine, of two upright telescoped shafts the inner of which projects above the other, bearings on said body permitting said shafts to revolve independently of each other and be held against movements in other directions, a motor of the type in which the motor shaft and the casing revolve in opposite directions mounted in said body, gearing between the motor shaft and one of said upright shafts, gearing between the motor casing and the other upright shaft, brake devices for decreasing the speed of rotation of either of said upright shafts, aerofoils on the upper ends of said upright shafts, and means to control the angle of attack of the aerofoils while the screws are revolving.

8. In a flying machine, two upright telescoped shafts the inner of which extends upwardly beyond the other, means to rotate said shafts in opposite directions, screws on the upper ends of said shafts, each screw comprising radial aerofoils mounted so as to swing about radial axes passing through the same, said areofoils having trailing portions hinged thereto, and control mechanism for said trailing portions to increase the angle of inclination between the same and the body portions of the corresponding aerofoils at either of two points in the rotary movements of the screws and decrease said angle at the point diametrically opposite the point at which the increase occurs.

9. In a flying machine, a rotatable screw comprising a series of radial aerofoils mounted so as to swing about radial axes passing through the same, each aerofoil having a trailing portion hinged thereto, the meeting edges of the body portion of each aerofoil and its trailing portion being shaped to produce between the same an air passage narrow at the top and terminating in a wide flaring mouth on the under side of the aerofoil.

In testimony whereof, I sign this specification.

FLOYD SMITH.