March 19, 1963 B. THAL 3,081,963

HELICOPTER WITH CENTRAL AIRFOIL

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FIG. 1

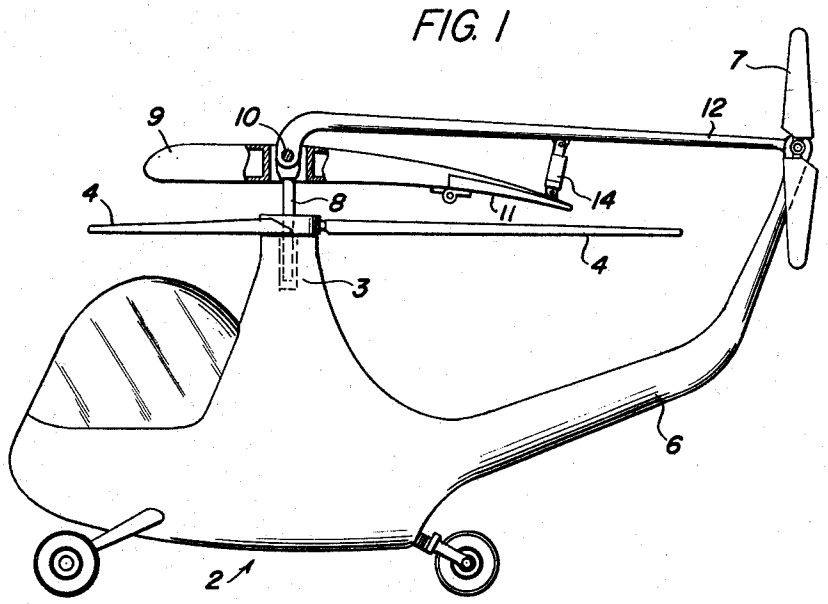
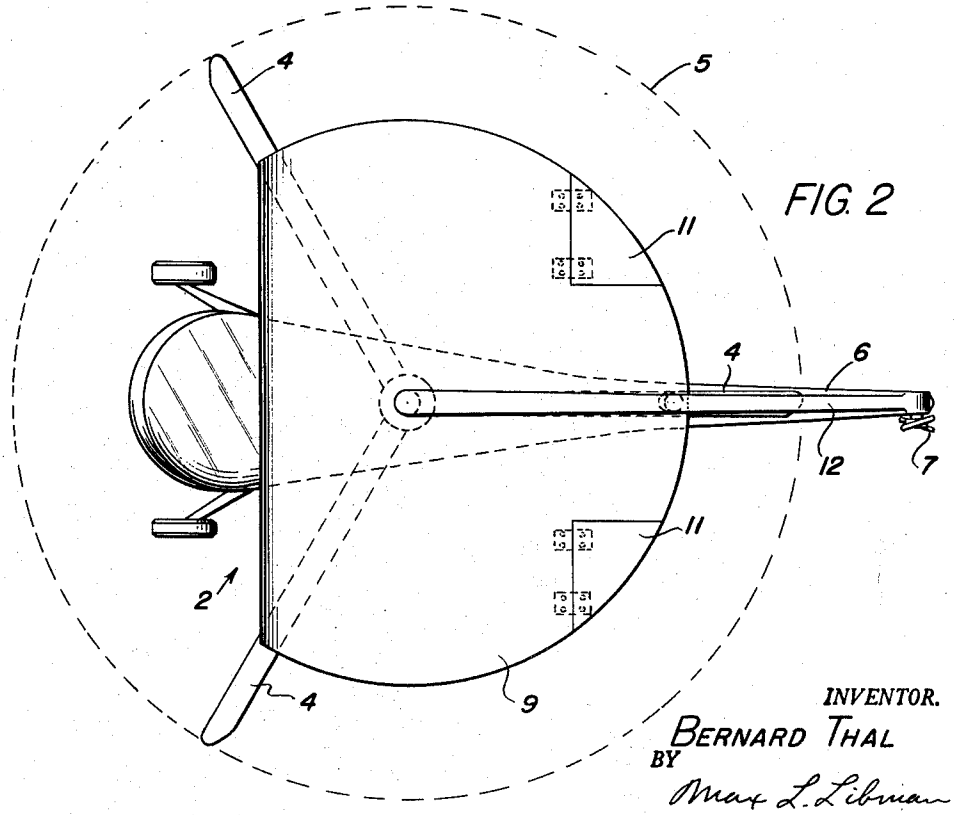



FIG. 2




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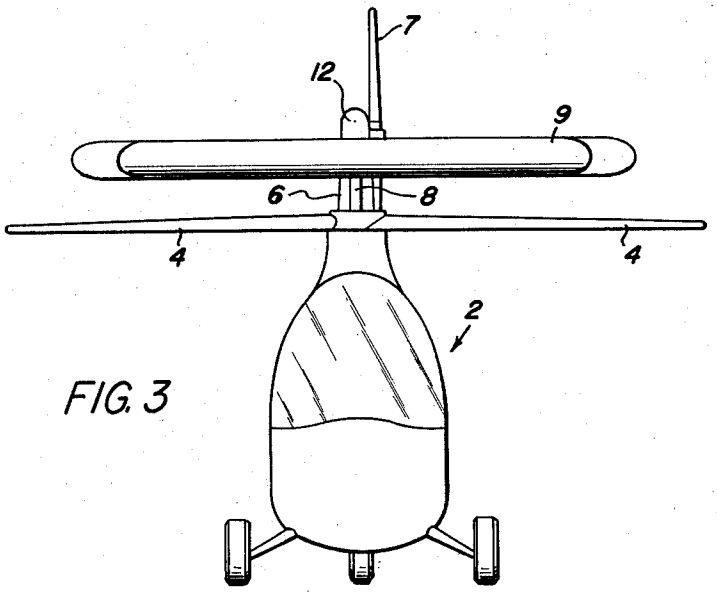



FIG. 3

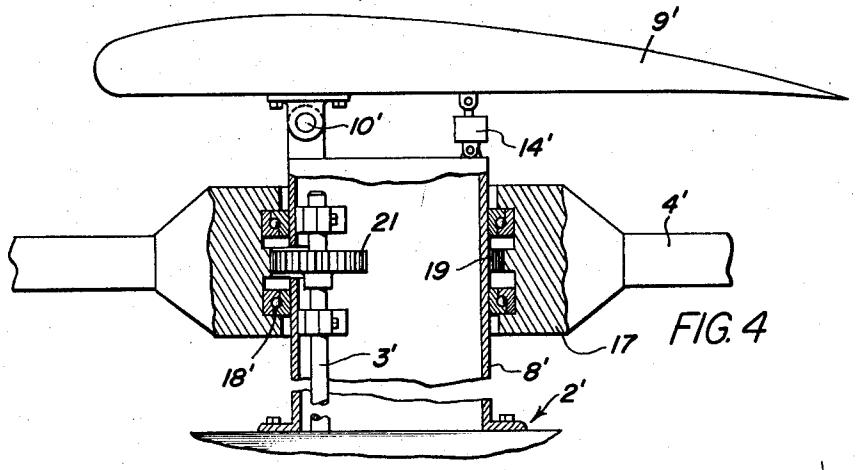



FIG. 4

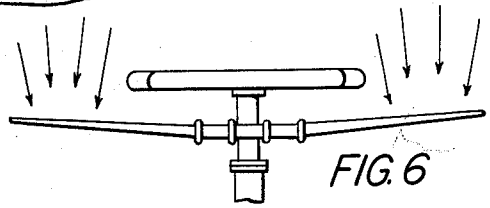


FIG. 6

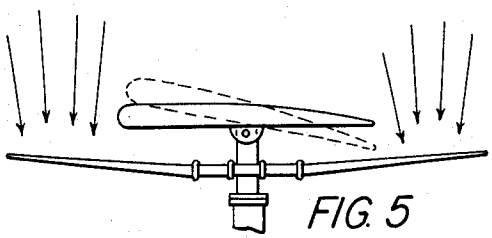


FIG. 5

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HELICOPTER WITH CENTRAL AIRFOIL

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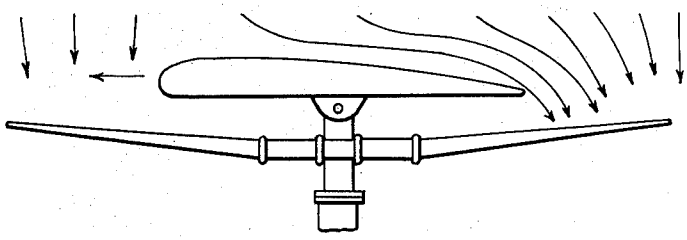


FIG. 7

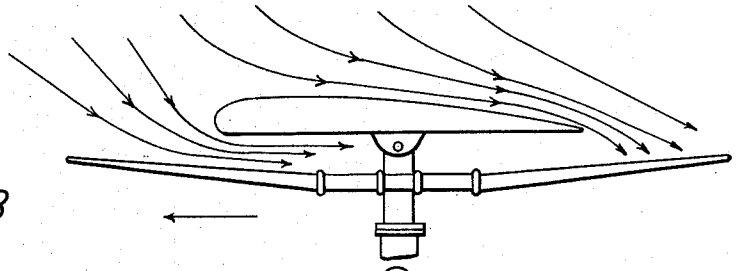


FIG. 8

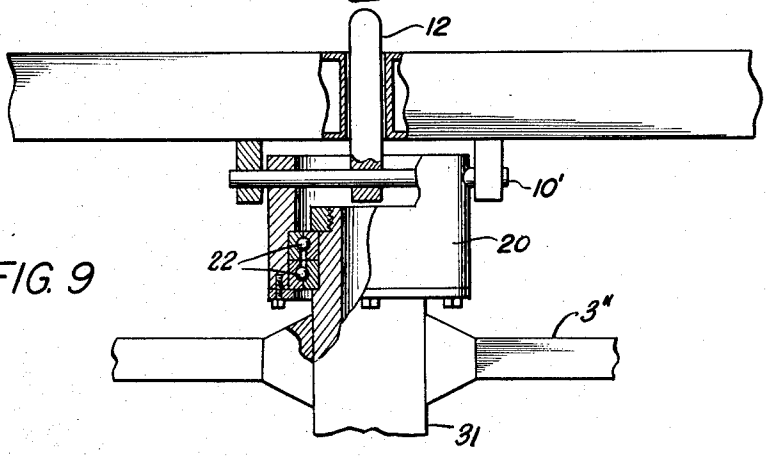



FIG. 9

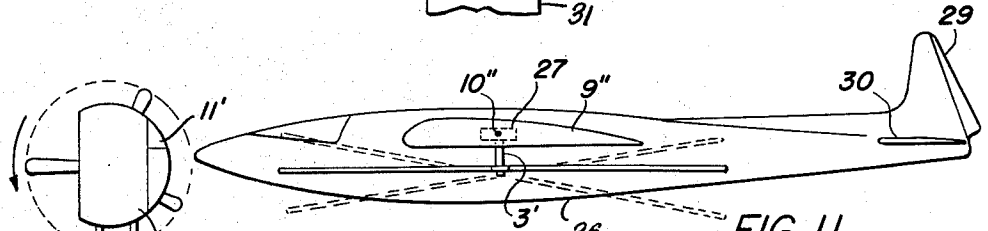



FIG. 11

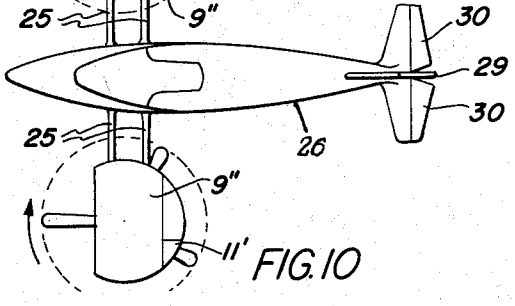



FIG. 10

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# HELICOPTER WITH CENTRAL AIRFOIL

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8 Claims. (Cl. 244—6)

This invention relates to helicopter-type airplanes and has for its primary object a provision of an efficient helicopter-type lifting and propulsion unit having more or less horizontal lifting blades rotating about a generally vertical axis, with an improved airfoil surface of substantially less diametric extent than the blade disc, mounted relatively concentric with and above the blade disc.

It is a major object of the invention to provide a helicopter-type vehicle of increased stability and improved aerodynamic efficiency as compared with conventional designs.

A further object is to improve the safety and extend the range of helicopters; a related object is to provide greater stability and control of a helicopter, both in powered flight, and in unpowered descent, and to provide greater safety and a slower rate of unpowered descent than with conventional helicopter construction.

The above and other objects are attained according to the invention by the provision of a non-rotating airfoil surface adjustably mounted above and relatively concentric with the lifting blades of the helicopter, said airfoil surface being substantially smaller in extent than the disc span of the blades.

A further object is to increase the load-carrying capacity of a helicopter so that, by using a short take-off run, a substantial increase in payload can be attained as compared with conventional helicopters.

The specific nature of the invention, as well as other objects and advantages thereof, will clearly appear from a description of a preferred embodiment, as shown in the accompanying drawings, in which:

FIG. 1 is a schematic side elevation of a helicopter according to the invention, showing the basic principle of operation;

FIG. 2 is a plan view, and FIG. 3 is a front elevation of the machine shown in FIG. 1;

FIG. 4 is a detail view of the airfoil support and blade drive of a modification;

FIGS. 5 and 6 are side and front views respectively of the rotor and airfoil unit, showing the air flow;

FIGS. 7 and 8 are side views similar to FIG. 5, showing the air flow under different operating conditions;

FIG. 9 is a detail view similar to FIG. 4, but showing a different modification of the support and blade drive construction; and

FIGS. 10 and 11 are plan and side views of a modified form of the invention.

Referring to FIG. 1, the helicopter is shown with the usual fuselage **2**, rotor **3**, rotor blades **4**, tail **6** and tail rotor **7**. These elements are all conventional in helicopters, and may be of any usual construction, except that in the present case the rotor assembly carries also a supporting post **8** for a non-rotating airfoil **9**, which is preferably mounted on a hinge **10** so that its angle with respect to the fuselage can be controlled by the pilot. A boom **12** serves to prevent the airfoil from rotation and holds it in the proper relation to the fuselage **2**. An airfoil position controlling mechanism **14** is provided, which may be a fluid cylinder and piston (or could be an electric motor drive), for controlling the angle of the airfoil **9**. The shaft **8** fits telescopically into rotor **3** and



the angle of airfoil **9** is changed by actuator **14**, which pivots the airfoil about hinge pin **10**.

As shown in FIG. 2, the airfoil **9** is preferably D-shaped in plan (although it could also be rectangular, circular or of any other shape), and is of considerably lesser diametric extent than the blade disc, which is indicated by the dotted line **5**. Ailerons **11** may be provided, if desired, preferably to be used as trimmers for controlling the stability of the helicopter in forward flight. Similarly a horizontal tail stabilizer and rudder of conventional design may be used. The details of the rotor articulation, i.e., the manner in which the blades are supported by the rotor, and the various degrees of freedom of blade motion permitted, are not shown, as these may be of any usual or conventional construction, except that, of course, the blades must not be permitted sufficient freedom of upward motion to strike the airfoils.

It will be understood that the airfoil **9** may be mounted in various ways, and that the boom **12** may be omitted, for example, as shown in FIG. 4. In this case, the airfoil support **8'** is fixed to the fuselage **2'**, while the rotor shaft **3'** is mounted for rotation within the support **8'**. The blades **4'** are mounted on a ring **17** supported by ball bearing **18'** for rotation external to the support **8'**, which is preferably faired or streamlined in cross-section except, of course, where it supports the ring **17**. Ring **17** is provided with internal gear teeth **19** driven by gear **21** attached to rotor shaft **3'**, and extending through the support housing **8'** into engagement with gear teeth **19**. The airfoil **9'** is mounted on hinge **10'**, on the top of support **8'**, and its angle can be varied by means of fluid piston **14'** also mounted on support **8'**. It will be understood that between the annular ring **17** and blade **4'**, the conventional articulation can be provided, the details of which are omitted as being no part of the present invention. Although the angle-adjusting motor **14'** is shown as a hydraulic motor, it will be understood that it may be of any desired type, including electrical, and is controlled by the pilot through control mechanism of any conventional type.

The airfoil diameter is shown as roughly one-half of the blade disc diameter, although this may be varied within reasonable limits. It will be apparent that by far the greatest effect of the rotor blades **4** is produced at the outer half of the radius of these blades, due both to their shape and to the fact that this portion of the blade is moving much more rapidly than the inner half; also, the area swept by the inner half is only one-fourth of the total disc area. The inner portion of the blade normally contributes very little to the airlift, and the provision of the airfoil **9** materially improves the efficiency of the entire blade assembly, both in forward motion and also in lifting motion, and in hovering condition.

FIGS. 5–8 show the airflow produced by the airfoil **9** and the rotor blade and indicate the manner in which the efficiency is increased. FIG. 5 illustrates the adjustable relationship in the relative positions of the airfoil and the rotor. FIG. 7 shows the condition when the rotor blades **4** first begin to move, sucking air downward around the periphery of the airfoil **9**. It will be noted that the air, as indicated by the arrows in front of the leading edge of the airfoil, moves straight down through the rotor blades **4**, while, due to the curvature of the back of the airfoil, the air at the trailing edge is collected in larger degree, causing an effective pressure against the trailing edge of the airfoil, which causes it to tend to move forward in the normal direction of flight of the helicopter. As the entire structure begins

to move in this direction and increases its speed, the rotor blades 4 lift the aircraft at the same time as it moves forward, thus giving in effect the functions of a helocopter to raise the craft in the initial turning of the rotor, and then at the will of the pilot by increasing the power and adjusting the airfoil 9 to the dotted line position (FIG. 5) the pilot causes the plane to take off in the vertical direction. It is readily possible for the vehicle to take off with a very short run if the space is available, but it can also be operated like a conventional helicopter at takeoff and landing.

As the forward motion of the helicopter increases, the airfoil section 9 serves more and more as an airplane wing to give increasingly greater lift and glide to provide swifter and more efficient flight. The range and speed will be correspondingly increased. By using a short run at takeoff, a heavier load can be lifted off the ground, due to the lifting action of the airfoil section 9 than would be possible by the rotation of the blades alone, and since a part of this load is necessarily fuel, at the landing point the weight will have been sufficiently reduced through normal fuel consumption so that the helicopter can now hover easily and land (or take off) vertically. However, even in the normal vertical take-off, the efficiency is increased. In this case, that is, for vertical take-off, the airfoil 9 is moved to a position more or less parallel to the plane of rotation of the blades, and the downward air flow at the center is deflected outwardly toward the effective portion of the disc area (that is, the unobscured portion) where it contributes more effectively to the lifting action than in the usual case; in the conventional helicopter this central air column only provides turbulence and inefficiency.

FIG. 9 shows a form of airfoil support which can be used with the boom structure of FIG. 1. In this case the rotor 3'' supports the airfoil through ball bearings 22 which permit the rotor 3'' to turn while supporting the airfoil 9, which is pivotally mounted on a pin or axle 10', which is fastened through housing 20 to the outer race of the ball bearings 22, and in turn supports both the airfoil 9 and the boom 12, while the latter prevents the airfoil from rotating and also adds to the rigidity of the structure, while permitting the airfoil to pivot on pin 10'. The airfoil angle can be controlled by any suitable means, e.g., as shown in FIG. 1, to change its angle of tilt with respect to the fuselage.

FIGS. 10 and 11 show the use of two propulsion units replacing the wings on a conventional aeroplane. The units are supported by booms 25—25 extending outward from the fuselage 26. The airfoil sections 9'' are fixed in normal position to the fuselage 26. The helicopter blades of the two units are driven in opposite directions. In this case, the engines 27 are pivotally mounted in the airfoil 9'' on axis 10'' which extends horizontally and at right angles to the direction of flight. The rotor is rigidly attached to the engine shaft 3' or the power output shaft if reduction gears are used. The engine 27, shaft 3 and rotor as a unitary structure, can then be adjusted for all flight requirements in relation to the airfoils 9''. If desired, in the single-rotor machine of FIG. 1 the engine may be similarly mounted on the wing, or airfoil, with the helicopter blades and rotor controls mounted on the downwardly extending rotor shaft. An engine with a suitable tractor propeller can be mounted in the nose of the fuselage for the purpose of giving added speed in any case, for forward flight. Normal rudder 29 and elevators 30, 30 may be used in this design. Ailerons 11', 11' and wing flaps may also be incorporated for further flight control if deemed necessary by the designers of the plane. Instead of the side-by-side rotors shown, it will be apparent that fore-and-aft rotors could be used as in the well-known "flying banana" design.

Instead of a D-shape, the airfoil shape can be completely circular in plan, with the same airfoil shape in cross-section. This will improve the flight stability, but will not give the directional characteristics imparted by the D-shaped airfoil.

Design of the airfoil section and its relative position with respect to the rotor will determine the aerodynamic effectiveness of the propulsion unit in that the air drawn over the top of the airfoil surface is smoothed by the suction of the rotor, and this same flow of air is further smoothed after it leaves the trailing edge of the airfoil by eliminating turbulence, which is a common cause of low efficiency.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of my invention as defined in the appended claims.

I claim:

1. A helicopter vehicle having a propulsion unit for both vertical and horizontal flight comprising a fuselage, lifting helicopter-type propeller blade means constituting a main thrust means for said vehicle supported from said fuselage and extending in a generally horizontal direction, and a non-rotatable generally horizontal airfoil surface mounted directly above said propeller blade means and also supported from said fuselage, said surface being of smaller maximum extent than the radial span of said lifting propeller blade means, measured horizontally from the axis of rotation of said blade means.

2. The invention according to claim 1, said airfoil surface being generally D-shaped in plan, with the straight edge of the D facing forward.

3. The invention according to claim 2, and adjustable ailerons symmetrically disposed at the trailing edge of the airfoil, said ailerons being hingedly movable upward and downward about a horizontal axis.

4. A helicopter propulsion unit for both vertical and horizontal flight comprising a fuselage, lifting helicopter-type propeller blade means constituting a main thrust means for said vehicle supported from said fuselage and extending in a generally horizontal direction, and a non-rotatable generally horizontal airfoil surface mounted directly above said propeller blade means and also supported from said fuselage, said surface being of smaller maximum extent than the radial span of said lifting propeller means, said airfoil surface being hingedly mounted for piovtal motion about a substantially horizontal axis extending substantially perpendicular to the direction of forward flight of the helicopter, and means for adjusting the angle of said airfoil about said axis to control flight characteristics of the helicopter.

5. The invention according to claim 4, including a drive shaft extending from said fuselage toward said propeller blade means and a housing fixed to and extending from said fuselage and surrounding said shaft, bearing means mounting said propeller means for rotation about said housing and external thereto, and a driving connection extending through said housing between said shaft and said propeller means for driving said propeller means from said shaft, said housing extending beyond said bearing means, and said airfoil surface being mounted on said housing.

6. The invention according to claim 4, and a rigid boom member extending from said axis to a portion of said fuselage and clearing said propeller means, to support said airfoil and prevent it from rotating.

7. The invention according to claim 1, there being two such units, each comprising a motor, shaft and airfoil surface, said units being respectively mounted on opposite sides and laterally away from said fuselage and said propeller blades being arranged to rotate in opposite directions.

8. The invention according to claim 1, said airfoil surface being generally circular in plan.

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5

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