Oct. 25, 1938. W. W. EVERTS 2,134,661

VARIABLE PITCH PROPELLER

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FIG. 1.

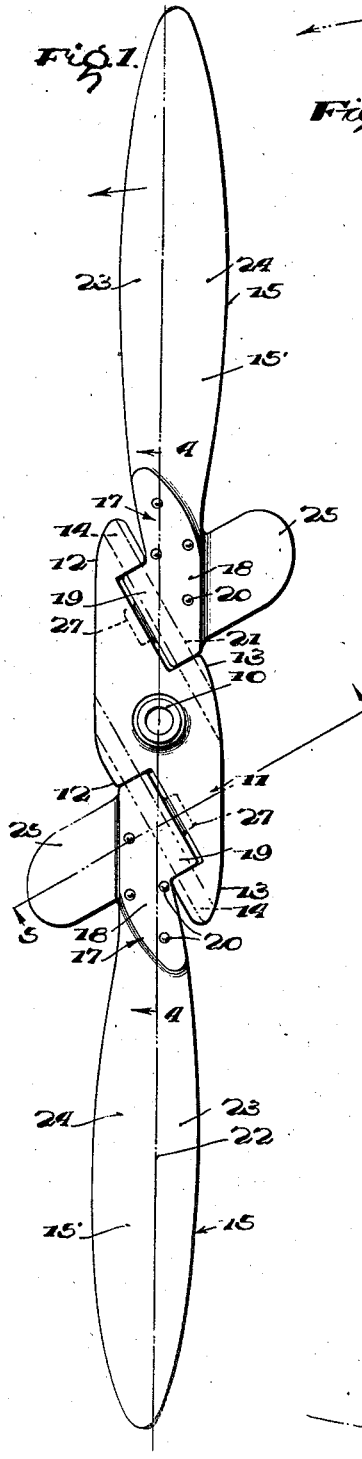


FIG. 2.

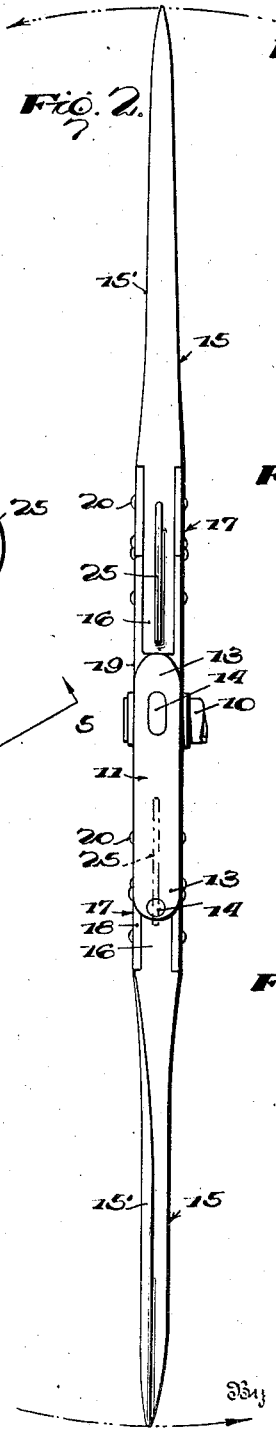


FIG. 3.

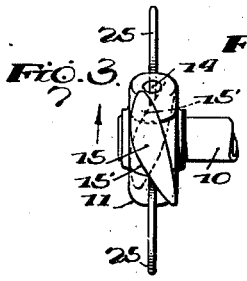


FIG. 4.

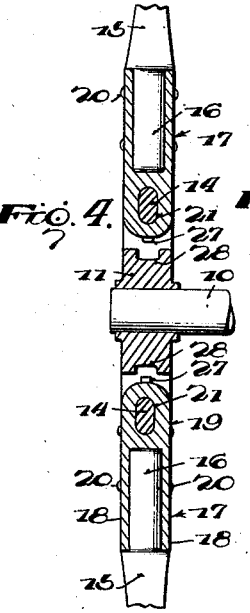


FIG. 5.

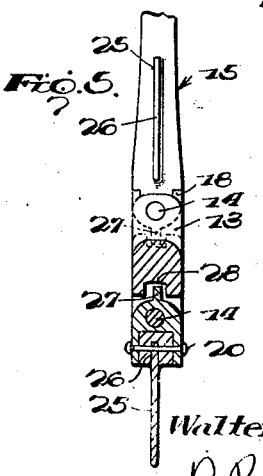


FIG. 6.

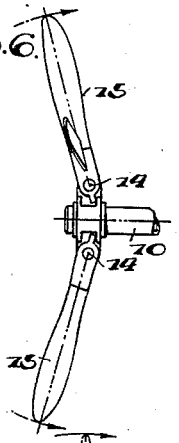


FIG. 7.

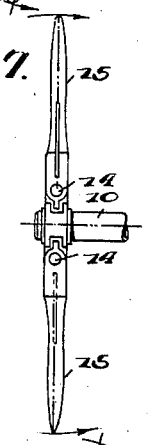
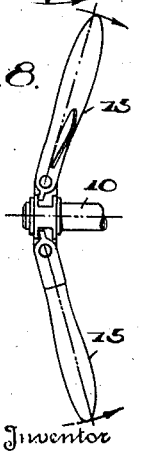


FIG. 8.



Inventor

Walter W. Everts

By B. P. Hollenbeck

Attorney

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Fig. 9.

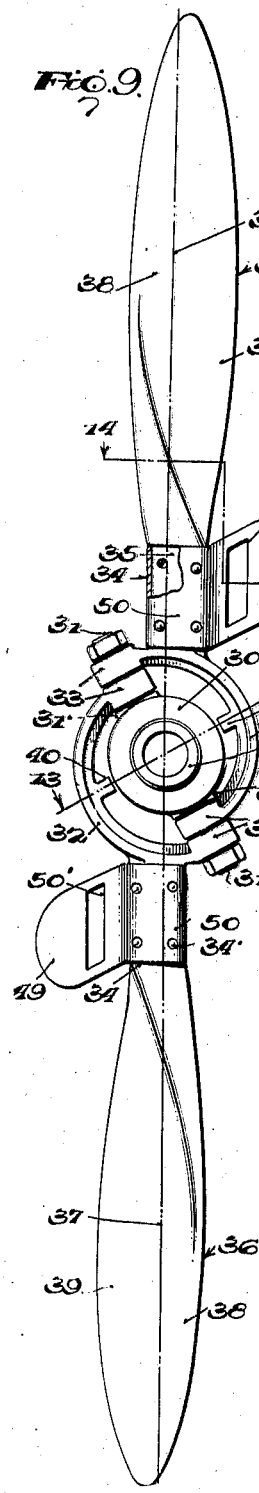


Fig. 10.

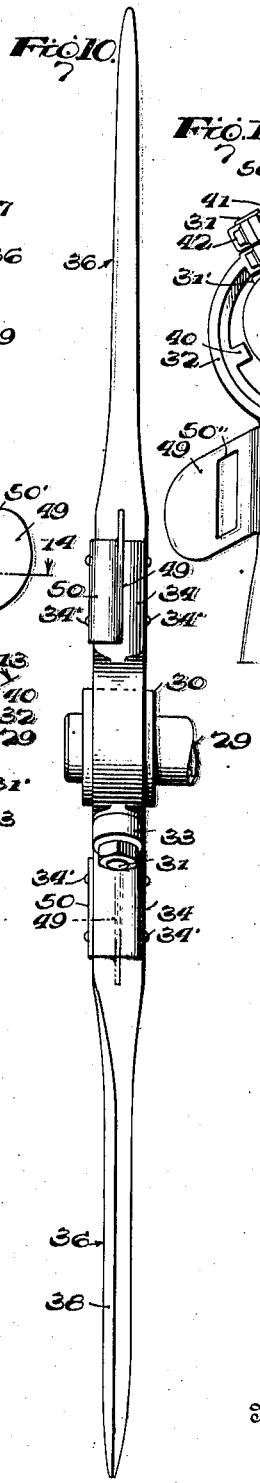


Fig. 11.

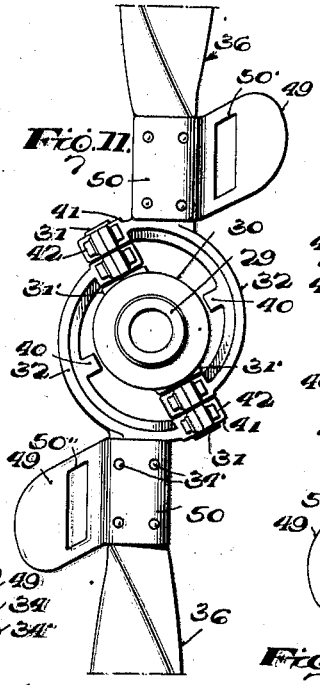


Fig. 12.

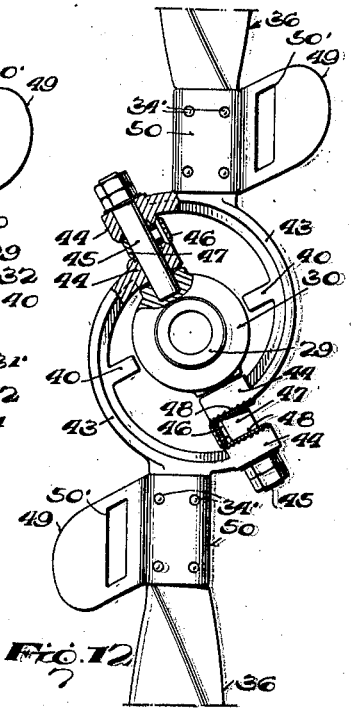


Fig. 13.

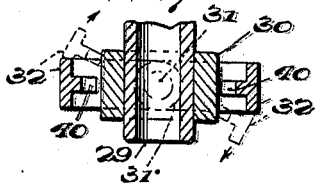
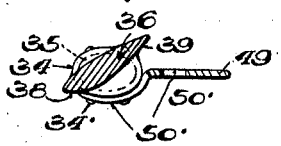


Fig. 14.



Inventor

Walter W. Everts

By B. P. Thompson

Attorney

Patented Oct. 25, 1938 2,134,661

UNITED STATES PATENT OFFICE

2,134,661

VARIABLE PITCH PROPELLER

Walter W. Everts, Baltimore, Md., assignor to Everel Propeller Corporation, Baltimore, Md., a corporation of Maryland

Application January 6, 1938, Serial No. 183,702

4 Claims. (Cl. 170—164)

My invention relates to propellers for air craft, boats, submarines or the like.

An important object of the invention is to provide a propeller having a blade which is so pivotally mounted that the pitch of the blade is increased by the action of centrifugal force, which action is opposed by the action of the fluid medium in which the blade is rotating, whereby the pitch of the blade increases when the pressure of the fluid medium decreases and the speed of rotation of the blade will remain substantially constant.

A further object of the invention is to provide a fin or blade which is acted upon by the pressure of the fluid medium, caused by the travel of the vehicle, which fin assists the action of centrifugal force in turning the blade for increasing its pitch, during the travel of the vehicle, but will have no such assisting action when the propeller is rotating while the vehicle is not travelling.

A further object of the invention is to provide a multiple blade propeller, the blades being independently pivotally mounted upon the hub or rotating element, so that their pitches may be varied.

A further object of the invention is to provide a propeller of the above mentioned character which is extremely simple in construction, formed of few parts and is reliable in operation.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this application and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a front elevation of a propeller embodying my invention, viewed from the front of the aeroplane,

Figure 2 is an edge elevation of the same,

Figure 3 is an end elevation of the propeller,

Figure 4 is a longitudinal section taken on line 4—4 of Figure 1,

Figure 5 is a transverse section taken on line 5—5 of Figure 1,

Figure 6 is an edge elevation of a propeller, partly diagrammatic, showing the blades at the minimum pitch,

Figure 7 is a similar view showing the blades at the maximum pitch due to the action of centrifugal force and reduced air pressure,

Figure 8 is a similar view showing the blades moved beyond the maximum propelling pitch, when the thrust of the atmosphere exceeds the pulling force of the blade, as when going into a nose-dive,

Figure 9 is a side elevation of a propeller embodying a modified form of the invention,

Figure 10 is an edge elevation of the same,

Figure 11 is a side elevation of a further modified form of propeller embodying my invention parts being broken away,

Figure 12 is a side elevation of a still further modified form of propeller embodying my invention,

Figure 13 is a transverse section taken on line 13—13 of Figure 9, and,

Figure 14 is a transverse section taken on line 14—14 of Figure 9.

In the drawings, wherein for the purpose of illustration are shown preferred embodiments of my invention, the numeral 10 designates a rotary driving element, such as the crank or drive-shaft of an internal combustion engine of an aeroplane. Rigidly mounted upon the shaft 10 is a hub 11, rotating with the drive-shaft. This hub is preferably in the form of a parallelogram, and is provided upon opposite sides with pairs of knuckles 12 and 13. These knuckles receive diagonally arranged pins or pivot elements 14, held therein by any suitable means. The pins 14 are parallel.

The numeral 15 designates blades, formed of any suitable material and twisted to produce the desired pitch. These blades 15 are of the conventional type, having the leading faces 15' convex or cambered. The inner ends or shanks 16 of these blades are arranged within sockets 17, including sides 18 and an inner end or base 19. The shanks 16 are held within the sockets 17 by bolts 20 or the like. The inner ends 19 of the sockets are provided with diagonal openings 21, to pivotally receive the pins 14. The blades 15 are therefore pivotally mounted upon their hub 11 to turn upon the pins 14. The openings 21 and the pins 14 are all diagonal with respect to the blades. Satisfactory results are obtainable by having these pins and openings disposed at an inclined angle of 30° with respect to the central longitudinal axis 22 of the blades 15. The invention is not restricted to this precise angle arrangement, as the same may be varied, anywhere between 90° and 0° with respect to the longitudinal axis 22. When the number of degrees is reduced, such as below 30°, as explained, the changing of the pitch of the blade is increased at a greater rate when the blade is turned upon its diagonal pivot. It is also preferred that the

leading and trailing portions 23 and 24 should be unbalanced with the trailing area larger.

An important feature of the invention is the provision of a pressure operated fin or blade 25, which is secured to each blade 15, near the hub 11. The fin or blade 25 is substantially flat on both sides and is not twisted. This fin is sufficiently stiff to hold its shape against its own weight, but is preferably resilient, and may be formed of metal. I have found that it may be formed of spring metal, having a thickness of 52/1000 of an inch. The fin may also be formed much thicker and rigid. This fin 25 has its inner end arranged within a slot or groove 26 cut in the shank 16 of the blade 15 and may be rigidly secured therein by any suitable means as by certain of the bolts 20. If the blade 15 is wooden, the fin 25 may also be formed of wood and glued to the blade 15. If the blade 15 is metal, the fin 25 could be cast integral with the blade. The fin 25 could also be bolted to one of the sides 18 of the socket 17. In any event, the fin or blade 25 is at the trailing edge of the blade 15 near or at the hub or crank shaft. It is preferred that the fin or blade 25 have its longitudinal axis arranged at a right angle to the pin 14, which will enable the fin to have the maximum leverage for utilizing the air pressure in aiding centrifugal force in turning the blade upon the pin 14 when the aeroplane is travelling.

The inner ends 19 carry stop lugs or extensions 27, arranged within recesses 28, formed in the hub 11. These stop lugs limit the swinging movements of the blades on the pins or pivots 14, so that the blades cannot fall to inoperative positions, but do not interfere with the normal operation of the blade in varying its pitch.

The operation of the propeller is as follows. When the engine is started, the propeller is turned counter-clockwise, viewed from the front of the aeroplane, which is the practice in the United States. As soon as the propeller rotates, centrifugal force acting upon each blade 15 tends to move the same to a radial position. This action of centrifugal force is opposed by the air thrust, which tends to swing the blade upon its pivot 14 so that the outer end of the propeller moves forwardly from the radial position. These two opposing forces act against each other and the blade will assume a normal operating position between the extreme forward position and the true radial position. Assuming that the aeroplane is now flying at substantially sea level, the air thrust is at the maximum and the blade has its outer end moved forwardly slightly from the radial position, so that the blade will have the minimum pitch. When the blade is turned upon its diagonal pivot 14 it is also turned upon its longitudinal axis, thereby varying the pitch of the blade. The unbalanced areas 23 and 24 also aid in turning the blade about its longitudinal axis, for when the blade turns upon the diagonal pivot 14 the longitudinal axis of the blade swings about the surface of a cone. The action of centrifugal force tends to move the blade upon its pivot 14 to the true radial position, thereby increasing the pitch of the blade. As the speed of the aeroplane increases, the air pressure acting upon the forward flat face of the fin 25 tends to turn the blade 15 upon its diagonal pivot 14, thus increasing the pitch of the blade. The fin 25 therefore aids the action of centrifugal force in turning the blade toward the rear or radial position, to increase this pitch. Assuming that the propeller is being driven at 2,000 R. P. M., at sea level, the propeller will then have the minimum pitch for this elevation. If the aeroplane now rises to a considerably higher elevation, the resistance acting upon the propeller will be reduced, while the action of centrifugal force would remain the same and hence the action of centrifugal force would overcome the air thrust upon the propeller blade and the propeller blade would be turned upon its diagonal pivot 14 in a rearward direction, turning the blade about its longitudinal axis for increasing the pitch of the propeller. This increased pitch of the propeller will cause the propeller to drive the aeroplane at an increased speed but the speed of rotation of the propeller will remain constant. The increased speed of the aeroplane will cause the air pressure to act upon the fin or blade 25 which will aid centrifugal force in turning the blade upon its pivot 14 to increase its pitch. By experiments which I have conducted, I have found that by combining the fin or blade 25 with the propeller blade, pivotally mounted as described, that the speed of rotation of the propeller will remain substantially constant, although the pitch of the blade will automatically change, when travelling from one elevation to the other.

Since the fins 25 have their forward and rear faces flat and not cambered, these fins only serve to aid in swinging the blades 15 upon their pivots to increase their pitch, when the aeroplane is travelling, and hence when the propeller is idling with the aeroplane stationary, the fins 25 do not function to vary the pitch of the propeller blades. This is important as it is desired that the blades have the minimum pitch in taking off. The fins 25 will not vary the pitch of the propeller blades when the propeller blades are rotating at any selected speed, provided the aeroplane is held against travelling.

Attention now being called to Figures 9 and 10, the numeral 29 designates a crank shaft or rotary driving element, having a hub 30 rigidly secured thereto. This hub is provided with diametrically oppositely arranged bosses 31', to which are secured diagonal pivot elements or pins 31, the inner ends of which may be screw-threaded into the bosses, and held against displacement by any suitable means. The shafts 31 are radial with respect to the crank shaft 29, and the central longitudinal axes of the shafts 31 are arranged to intersect with the central longitudinal axis of the shaft 29. The numeral 32 designates companion oppositely arranged attaching yokes, provided at their ends with collars 33, pivotally mounted upon the shafts 31, and arranged as shown. These attaching yokes 32 are provided with radially extending sockets 34, preferably formed integral therewith. The sockets 34 receive the shanks 35 of propeller blades 36, which are substantially identical with the propeller blades 15, having the same central longitudinal axis 37, corresponding to the axis 22, and the unbalanced areas, 38 and 39 with the front face of the blade convex or cambered and the rear face substantially flat, as shown in connection with the first form of propeller. Attention is called to the fact that the pins 31 are diagonally arranged with respect to the longitudinal axes 37 of the blades 36 and are preferably disposed at an angle of 30° with relation to the axes 37, as described in connection with the first form of the invention. As more clearly shown in Figures 9 and 13, the attaching yokes 32 are provided with inwardly projecting lugs or ribs 40, arranged to contact with the periphery of the hub 30, to limit the swinging movement of

the blades upon the shafts or pivots 31, so that these blades cannot fall to inoperative positions when the propeller is at rest, but these stops or lugs 40 do not interfere with the proper swinging movements of the blades upon their pivots 31 to vary the pitch of the same.

In Figure 11, a further modification of the invention is shown. In this figure, the yokes 32 have collars 41, which are split, and the portions of the collars connected by bolts 42. When this construction is used the pins 31 may be formed integral with the hub 30, if desired.

In Figure 12, a further modification is shown wherein yokes 43 are employed, similar to the yokes 32 but slightly elongated. These yokes have collars 44 formed on their ends, pivotally mounted upon shafts 45, corresponding to the shafts 31. These shafts are rigidly attached to the hub 30. Arranged between the collar 44 of one yoke 43 and the collar 44 of the other yoke is a bevel gear 46, pivotally mounted upon a ring 47, clamped to the shaft 45. The bevel gears 46 engage gear teeth 48, as shown. The function of these bevel gears is to connect the yokes 43, thereby insuring that they swing in unison upon their pivots. However, since the propeller blades and all parts associated therewith are balanced, the blades turn in unison in opposite directions upon their longitudinal axes without the bevel gears.

In the modified forms of the invention shown in Figures 9 to 12 inclusive, a fin or blade 49 is employed in connection with each blade 36. This fin or blade 49 corresponds to the fin 25 and it may be resilient. The fin 49 has its front and rear faces flat. Each fin 49 has an attaching extension 50, secured to the socket 34 by the bolts 34'. The fin 49 has its longitudinal axis disposed at a right angle to the longitudinal axis of the pins 31. In order that the fin 49 may offer no substantial resistance to the air passing over the socket 34, this fin is provided with an air slot 50', near its inner end and adjacent to the socket 34. All other parts of the forms of the inventions shown in Figures 11 and 12 remain identical with that shown in connection with Figures 9 and 10

The operation of the propeller shown in Figures 9 and 10, with respect to the swinging of the blades 36 upon the diagonal pivot or pivots 31 is similar to the operation as described in connection with Figures 1 to 8 inclusive. The operation is different to the extent that the blades 36 turn about diagonal pivot or pivots which have their central longitudinal axes extending through the central longitudinal axis of the drive shaft 29. The advantage of the construction shown in Figures 9 and 10 is that the effective area of the blades may be increased. The blades 36, when the propeller is rotating at sea level, are at the minimum pitch and hence are inclined forwardly with respect to the radial, as shown in Figure 6, but when the aeroplane rises to a higher elevation, with the speed of rotation remaining the same, the blades 36 swing rearwardly toward the radial position, increasing the pitch. The operation of the propellers shown in Figures 11 and 12 is the same as those described in connection with Figures 9 and 10. The fins 49, when the propeller is rotating and the aeroplane is travelling, are acted upon by air pressure and aid centrifugal force in swinging the blades rearwardly, toward the radial position, to increase their pitch. The action of the fins 49 is the same as the fins 25.

It is to be understood that the forms of my invention herewith shown and described are to be taken as preferred examples of the same and that various changes in the shape, size, and arrangement of parts may be resorted to without departing from the spirit of my invention or the scope of the subjoined claims.

Having thus described my invention, what I claim is:

1. A propeller for aeroplanes and other vehicles, comprising a rotary driving element, a blade having its longitudinal axis arranged generally radially of the rotary driving element, said blade having unbalanced leading and trailing surfaces so that the resistance of the air due to the rotation of the blade will tend to move the blade about its longitudinal axis to reduce its pitch, pivot means mounting the blade upon the rotary driving element, the pivot means having a turning axis disposed in a plane at substantially a right angle to the axis of rotation of the rotary driving element and arranged diagonally with relation to the longitudinal axis of the propeller blade, the propeller blade being free within limits to swing laterally upon the diagonal turning axis due to the action of centrifugal force for increasing the pitch of the blade, and stop means to positively limit the lateral swinging movement of the propeller blade upon the diagonal axis beyond such limits.

2. A propeller for aeroplanes and other vehicles, comprising a rotary driving element adapted to be arranged generally horizontally in use, a blade having its longitudinal axis arranged generally radially of the rotary driving element, said blade having unbalanced leading and trailing surfaces so that the resistance of the air due to the rotation of the blade will tend to move the blade about its longitudinal axis to reduce its pitch, pivot means mounting the blade upon the rotary driving element, the pivot means having a turning axis disposed in a plane at substantially a right angle to the axis of rotation of the rotary driving element and arranged to intersect with the rotary driving element, said turning axis being disposed diagonally with relation to the longitudinal axis of the propeller blade, the propeller blade being free within limits to swing laterally upon the diagonal turning axis due to the action of centrifugal force acting upon the blade for increasing the pitch of the blade, the blade swinging toward the radial position by centrifugal force, and stop means to positively limit the lateral swinging movement of the propeller blade upon the diagonal axis beyond such limits.

3. A propeller for aeroplanes and other vehicles, comprising a rotary driving element adapted to be arranged generally horizontally in use, a blade having its longitudinal axis arranged generally radially of the rotary driving element, said blade being so constructed that the resistance of the air due to the rotation of the blade will tend to move the blade about its longitudinal axis to reduce its pitch, pivot means mounting the blade upon the rotary driving element, the pivot means having a turning axis which is substantially radial with relation to the axis of rotation of the rotary driving element, said turning axis being disposed diagonally with relation to the longitudinal axis of the propeller blade, the propeller blade being free within limits to swing laterally upon the diagonal turning axis, the propeller blade being acted upon by centrifugal force to swing the propeller blade toward the radial position for increasing the pitch of the blade, stop means to limit the lateral swinging movement of the propeller blade beyond the limits of movement, and a fin secured to the propeller blade near the inner end of the

propeller blade and near its trailing edge, the fin being acted upon by air pressure caused by the travel of the aeroplane or the like, the fin moving rearwardly with respect to the direction of travel of the aeroplane or the like and aiding the action of centrifugal force to increase the pitch of the propeller blade.

4. A propeller for aeroplanes and other vehicles, comprising a rotary driving element adapted to be generally horizontally arranged in use, yokes arranged upon opposite sides of the rotary driving element, pivot means mounting the yokes upon the rotary driving element and having a turning axis arranged radially of the rotary driving element, the yokes swinging laterally upon the turning axis in a direction longitudinally of the rotary driving element, means to limit the swinging movements of the yokes, propeller blades carried by the yokes and extending in opposite directions, each blade having a longitudinal axis arranged generally radially of the rotary driving element, each blade being so constructed that the resistance of the air due to the rotation of the blade will tend to move the blade about its longitudinal axis to reduce its pitch, the turning axis of the pivot means being disposed diagonally with relation to the longitudinal axis of each propeller blade, the propeller blade being acted upon by centrifugal force to swing the same toward the radial position for increasing the pitch of the blade, and a fin secured to each propeller blade near the inner end of the same and near its trailing edge, the fin being acted upon by air pressure caused by the travel of the aeroplane or the like for moving the fin rearwardly with respect to such direction of travel, the fin then aiding the action of centrifugal force to increase the pitch of the propeller.

WALTER W. EVERTS.