Oct. 25, 1938. W. W. EVERTS 2,134,660

ADJUSTABLE PROPELLER

Original Filed Aug. 25, 1936 2 Sheets-Sheet 1

Fig. 1.

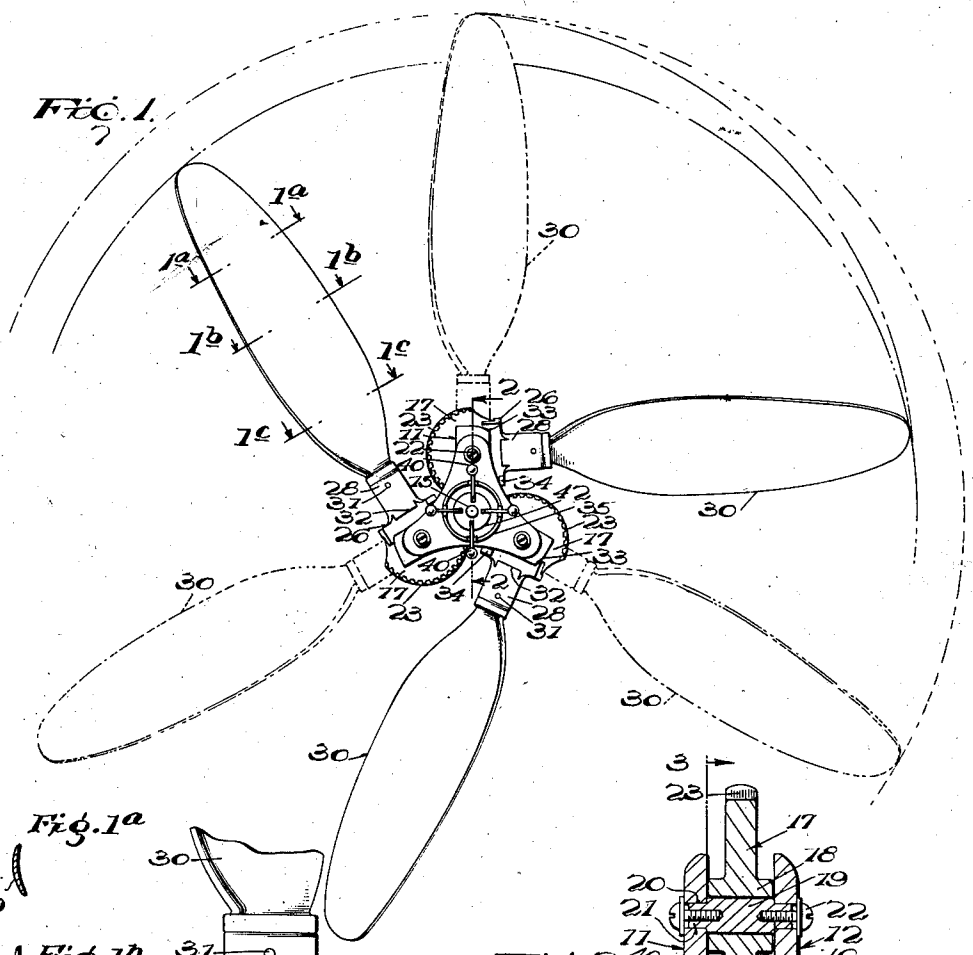


Fig. 1a

Fig. 1b

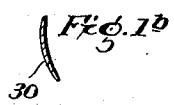
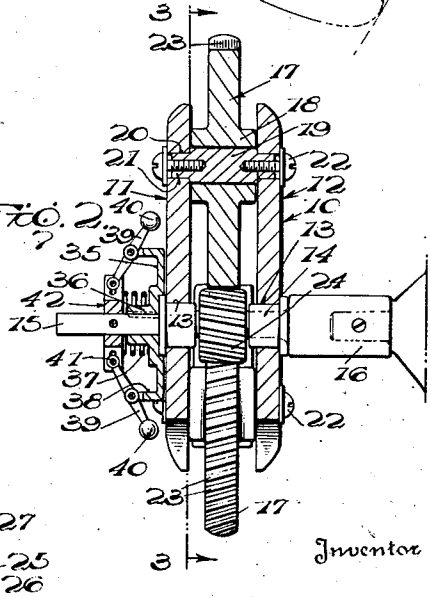


Fig. 1c



Fig. 3.

Fig. 2.



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Fig. 5.

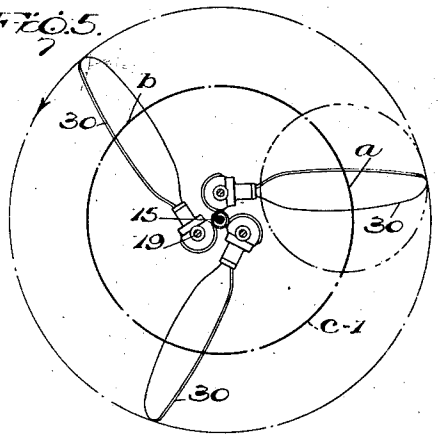


Fig. 5a

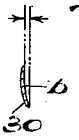


Fig. 4.

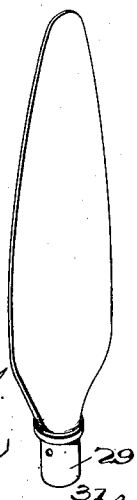


Fig. 6.

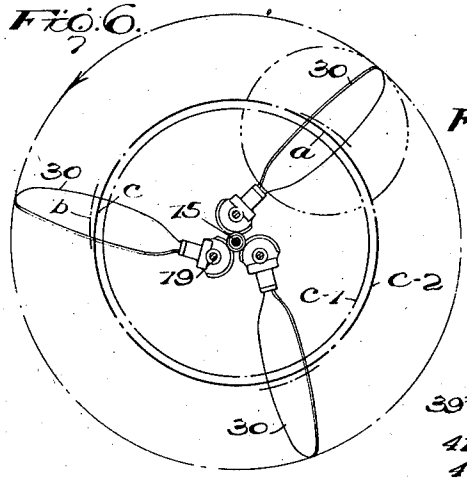


Fig. 6a

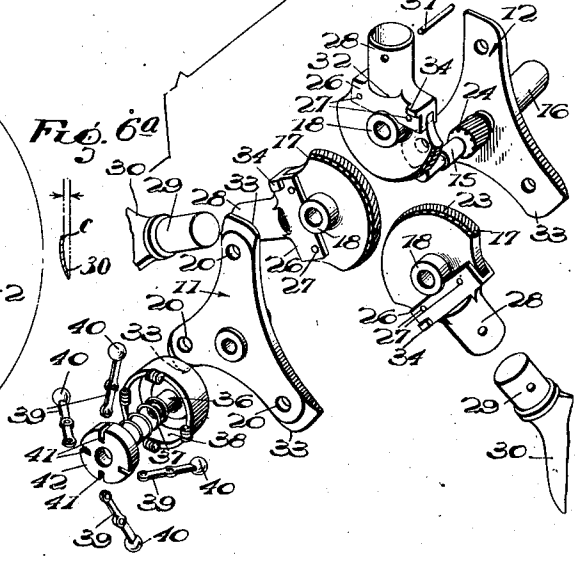


Fig. 7.

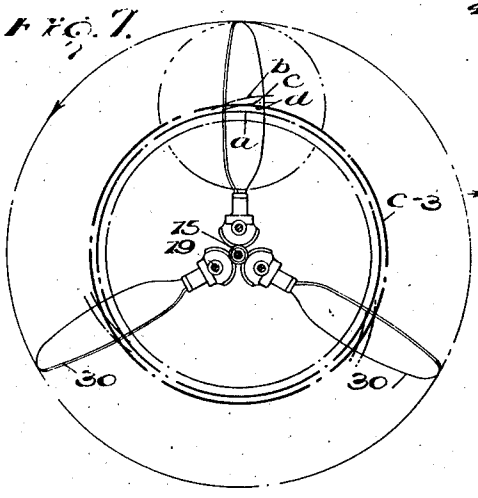


Fig. 7a



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2,134,660

ADJUSTABLE PROPELLER

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

Application August 25, 1936, Serial No. 97,865
Renewed May 14, 1938

6 Claims. (Cl. 170—164)

My invention relates to propellers for aircrafts.

An important object of the invention is to provide a propeller having a blade or blades which are automatically adjustable for varying the sweep of the same as the air pressure varies, thereby providing a propeller having a uniform pull at varying altitudes, at the same speed of rotation of the driving shaft.

A further object of the invention is to provide a propeller of the above mentioned character having a blade or blades which are adjustable in the plane of rotation of the propeller, to vary the sweep of the blade or blades.

A further object of the invention is to provide a propeller of the above mentioned character which may have one or more blades.

A further object of the invention is to provide a propeller of the above mentioned character, the blade or blades of which are automatic in adjustment, and move outwardly to increase the sweep of the same, as the atmospheric pressure is reduced.

A further object of the invention is to provide a propeller of the above mentioned character having means to hold the blade or blades against adjustment, when the propeller is at rest or rotating at a relatively low speed, and to release the same, so that the automatic adjustment may occur when the propeller is rotating at a sufficiently high speed to be properly acted upon by the air torque resistance and centrifugal force.

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,

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

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

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

Figure 2 is a transverse vertical section taken on line 2—2 of Figure 1,

Figure 3 is a vertical section taken on line 3—3 of Figure 2,

Figure 4 is an exploded perspective view of the propeller,

Figure 5 is a front face view of the propeller, partly diagrammatic, showing the blades with their longitudinal centers travelling in the inner circle, and the angle of slip stream,

Figure 5*a* is a transverse section through the blade taken on the circle C—1 of Figure 5,

Figure 6 is a similar view showing the blades moved outwardly so that their longitudinal centers travel in an outer circle, showing the angle of slip stream at the outer circle,

Figure 6*a* is a transverse section taken on the circle C—1 of Figure 6,

Figure 7 is a similar view showing the blades moved outwardly for a greater distance so that their longitudinal centers travel in a still larger circle, and the angle of slip stream at the still larger circle, and,

Figure 7*a* is a transverse section taken on the circle C—1 of Figure 7.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of my invention, the numeral 10 designates a hub or rotary element, as a whole, comprising front and rear hub plates 11 and 12, which are preferably generally triangular, as shown. These hub plates have central openings 13 to receive bushings 14, which rotatably receive the drive shaft 15. This drive shaft is equipped with a sleeve or coupling 16 to be suitably clamped to the crank shaft of the engine mounted in or upon the aircraft.

Arranged between the hub plates 11 and 12 are gear segments or gears 17, having spacing hubs 18, rotatably mounted upon stub shafts or axles 19, in turn having reduced ends 20, arranged within openings 21. The reduced ends are retained within the openings 21 by set screws 22 or the like. The segmental gears 17 are identical in diameter and are circumferentially equidistantly spaced and also radially equidistantly spaced from the drive shaft. The segmental gears 17 preferably have spiral teeth 23, and these teeth engage a common spiral gear 24, rigidly mounted upon the drive shaft 15, between the hub plates 11 and 12, as shown. The gears 24 and 17 serve to hold the blades in proper circumferentially spaced relation.

The segmental gears 17 have outer straight edges 25, disposed at a right angle to the radial axes of the segmental gears 17 which are radial to the hub 10 when the segmental gears are in the outermost position, as shown in Figure 3. The numeral 26 designates sockets which extend generally circumferentially of the hub 10, when the segmental gears are in the outermost position, Figure 3, and the circumferentially extending sockets straddle the outer ends or edges 25

of the segmental gears and are rigidly secured thereto by rivets 27. If desired, the sockets 26 may be integral with the segmental gears 17. Preferably formed integral with the sockets 23 are cylindrical generally radial sockets 28, which are radial with respect to the hub 10, when the sockets 28 are in the outermost position. These sockets have cylindrical recesses to receive cylindrical shanks 29 of blades 30. The shanks 29 are inserted into the radial sockets 28 and the blades 30 are turned until they assume the selected pitch, after which the blades are locked to the sockets 28 by a set screw 31 or other suitable means, and are accordingly held against turning movement upon their longitudinal axes with respect to the sockets 28. Each blade 30 is twisted upon its longitudinal axis, so that its pitch increases inwardly, as indicated by the sections on Figure 1. This is the conventional construction of a propeller blade.

Means are provided to limit the outward movement of the blades 30 beyond the radial position, Figure 3, such means comprising shoulders 32, formed upon the opposite sides of each socket 28, and these shoulders are arranged to engage the cam faces 33 of the hub plates 11 and 12, as shown. Means are also provided to limit the inward movement of the blades 30, comprising laterally extending stop lugs 34, formed integral with the segmental gears 17, and positioned to contact with the edges of the hub plates 11 and 12, when the blades 30 are positioned at the innermost position, Figure 1.

Clutch means are provided to lock the hub 10 with the drive shaft 15 when the propeller is standing still or rotating at a slow speed, as when starting or stopping. This clutch means is centrifugally operated, and comprises a friction clutch element or disk 35, arranged to frictionally engage the face of the hub plate 11. The friction disk 35 has a hub portion 36, which is splined on the drive shaft 15 to turn therewith and move longitudinally thereof. The friction disk is moved in one direction to engage the hub plate 11 by a compressible coil spring 37. The friction disk 35 has arms 38 rigidly secured thereto, upon which are pivoted governor arms 39, carrying weights 40. The inner ends of these governor arms are provided at 41 with a pivot slot connection, with a cross head 42, which is rigidly attached to the drive shaft 15.

The operation of the propeller is as follows:

Assuming that the blades 30 are in the inner or retracted position, for operation at substantially sea level, then the sweep of the blades will be at the minimum, as shown in Figure 5. When the propeller is at rest, the clutch, including the clutch element 35, locks the hub 10 to the drive shaft 15. When the engine is started and the propeller is rotating at a relatively low speed, the clutch still retains the hub 10 locked to the shaft 15, for rotation therewith. When the speed of rotation increases above this relatively low speed, the weights 40 are acted upon by centrifugal force and the clutch automatically releases the hub 10 from its locked engagement with the shaft 15, and the shaft 15 is then free to turn with relation to the hub, within limits. When the shaft is unlocked from the hub, the shaft rotates the hub through the medium of the gears 17 and 24, the hub and blades rotating as a unit. As the shaft 15 rotates counter-clockwise, the blades will turn upon their transverse axes and move to the radial position, due to the action of centrifugal force, against the gear and air torque. This unlocking occurs at about the time that the propeller blades are rotating sufficiently fast to be acted upon by air torque resistance and centrifugal force, to automatically adjust the same without subjecting the parts to undue shocks. Assuming that the propeller is now rotating with the hub 10 unlocked from the driving shaft, and that the propeller is at substantially sea level and acted upon by the maximum air torque resistance, the shaft 15 now rotates the propeller, and the air torque resistance acting upon the propeller blades moves the propeller blades inwardly to or near the innermost position, Figure 5, so that the blades have the minimum sweep. This sweep will be sufficient to give the propeller proper pulling action at or near sea level. The air torque resistance acting upon the rotating propeller blades is sufficient to slightly overcome the action of centrifugal force, which would tend to turn the propeller blades upon the pivots 19 in an outward direction to shift the same angularly and radially to thereby increase the sweep of the blades. With the shaft 15 rotating at the same speed, and with the propeller now moving to a higher elevation, the air torque resistance is reduced and the air torque resistance acting upon the propeller blades, now in the innermost position, is reduced, with the result that centrifugal force can now overcome the action of the air torque resistance upon the propeller blades and the propeller blades turn upon their pivots 19, thus swinging forwardly in their path of rotation, in opposition to the air torque resistance and moving radially outwardly, thereby increasing the sweep of the blades. This is indicated in Figure 6. With the increased sweep of the blades, the air torque resistance is correspondingly increased so that it will again slightly overcome the action of centrifugal force and the blades will be held in the adjusted position, with the increased sweep. As the propeller continues to rise to successively higher elevations, the air torque resistance is further reduced until the minimum air torque resistance may be reached, the blades automatically turning forwardly upon their pivots, in their plane of rotation, and moving radially outwardly to increase their sweep, until the maximum sweep of the blades is obtained, Figure 7. At this time, the air torque resistance acting upon the blades will overcome the action of centrifugal force at or about the time that the blades reach the outermost position. It is thus seen that as the propeller rises to successive elevations, the blades have their sweep increased due to their radial outward movement caused by centrifugal force and the outward movement is checked or stopped due to the correspondingly increased air torque resistance acting upon the greater sweep of the blades. The blades therefore have their sweep increased as the elevation is increased and the blades therefor have a uniform propelling action, as the air pressure decreases, with the drive shaft operating at the same speed. The radial shifting of the blades to vary their sweep is caused by the opposing forces of air torque resistance and centrifugal force. The air torque resistance is sufficient to slightly overcome the action of centrifugal force at any given elevation, at a constant rotation of the shaft 15, but as the elevation is increased and the air pressure reduced, the air torque resistance is accordingly reduced and centrifugal force will then adjust the blades outwardly to increase their sweep for the proper extent for such higher elevation, and after the sweep has been increased,

the air torque resistance will again retain the blades in the last adjusted position.

In Figure 5, the blades 30 are in the innermost position and are somewhat at a tangent to the drive shaft 15 and are at acute angles to the radii of the drive shaft. The center *a* of each propeller blade 30 is now travelling in the inner circle *c*—1. This circle *c*—1 has the drive shaft 15 as its center. The angle of slip stream is designated by *b*. The angle of slip stream *b* is at approximately a right angle to the longitudinal axis of the propeller blade. A section cut through the propeller blade at the angle *b* shows the pitch of the blade at the center *a* of the blade when the center *a* is travelling within the inner circle *c*—1. In Figure 6, the propeller blades 30 have moved outwardly by the action of centrifugal force so that the center *a* of the blade is travelling in an outer circle *c*—2, having the shaft 15 as its center. As the blades 30 travel outwardly radially, they also turn transversely upon their pivots 19 and assume positions nearer to the radial line from shaft 15 that passes through pivot 19. The blades therefore have their longitudinal axes angularly adjusted with respect to the shaft 15. The angular adjustment of the blades and their radial movement occurs in the plane of rotation of the blade. The center *a* of the blades 30 now travels in the outer circle *c*—2, having an angle slip stream *c*, which is generally at a right angle to the longitudinal axis of the blade. A transverse section through the propeller blade taken at *c*—1 will show an increased angle of pitch of the blade, since the inner portion of the blade has moved outwardly into the circle *c*—1. In Figure 7, the center point *a* of the blade has moved into the further outer circle *c*—3, and due to the further angular adjustment of the longitudinal axis of the blade with respect to the shaft 15, the longitudinal axis of the blade is radial with respect to the shaft 15 and the angle of slip stream is indicated at *d*, which is generally at a right angle to the longitudinal axis of the blade. A section through the blade taken at the circle *c*—1, is shown in Figure 7, and indicates that the pitch of the blade at this circle *c*—1 is increased, since the inner portion of the blade has moved outwardly into the circle *c*—1. It is thus seen that as the center point of the blade moves radially into different positions, indicated by the circle *c*—1, *c*—2 and *c*—3, that the angle of slip stream remains generally at a right angle to the longitudinal axis of the blade, thus rendering the blade efficient in operation. The same action occurs with respect to every other point in the blade, throughout its length, as it is shifted radially outwardly into different positions. The pitch of the blade on the succeeding outer circles increases with the outward movement of the blade, since the pitch of the blade increases from its outer end inwardly.

In the embodiment of my invention shown, the spiral gear 24 is of smaller diameter than the segmental gears 17, which is proper for producing the suitable leverage between the propeller blades and the shaft 15, taking into consideration the size and area of the propeller blades. When the size, area or pitch of the blades vary, the gear ratio will also be varied.

While I have shown and described my propeller as employing three blades, yet the invention is not restricted to this arrangement, as the propeller may be made with one blade, two blades, or any number of blades.

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

Having thus described my invention, I claim:

1. A propeller for aircrafts, comprising a hub, a blade swingingly mounted upon the hub at a point outwardly of the axis of rotation of the hub so that the blade can swing upon its pivot in the plane of rotation of the hub, a drive shaft constituting the axis of rotation of the hub and adapted to turn with relation to the hub, a gear rigidly secured to the inner end of the blade, and a gear carried by the drive shaft and engaging the first named gear.

2. A propeller for aircrafts, comprising a hub, a drive shaft upon which the hub is rotatably mounted, blades pivotally mounted upon the hub radially outwardly of the drive shaft to turn in the plane of rotation of the hub, gears connected with the blades, and a gear carried by the drive shaft and arranged between the first named gears and engaging therewith.

3. A propeller for aircrafts, comprising a drive shaft, a hub rotatable upon the drive shaft, gears pivotally mounted upon the hub at points radially outwardly of the drive shaft to turn in the plane of rotation of the hub, blades mounted upon the gears, and driving means between the drive shaft and said gears.

4. A propeller for aircrafts, comprising a drive shaft, a hub rotatably mounted upon the drive shaft, a blade pivoted upon the hub eccentrically of the drive shaft, gearing connecting the drive shaft and blade, and a centrifugal clutch device locking the drive shaft and hub for rotation as a unit and actuated by centrifugal force to unlock the same so that the drive shaft can turn with relation to the hub.

5. A propeller, comprising a rotary element, a blade pivotally mounted upon the rotary element to bodily rotate therewith and turn upon its transverse axis in generally the plane of rotation of the blade, a drive shaft, and gearing connecting the drive shaft and blade to turn the same upon its transverse axis.

6. A propeller for aircrafts, comprising a rotary driving element, a rotary hub arranged near the rotary driving element, a clutch device for connecting the rotary driving element and rotary hub so that they rotate together, centrifugal means operating the clutch device for disconnecting them when the rotary hub reaches a selected speed, a blade pivotally mounted upon the rotary hub, and driving connecting means between the rotary driving element and the blade serving to turn the blade upon its pivot and also causing the blade to rotate the rotary hub.

WALTER W. EVERTS.