

May 24, 1938.

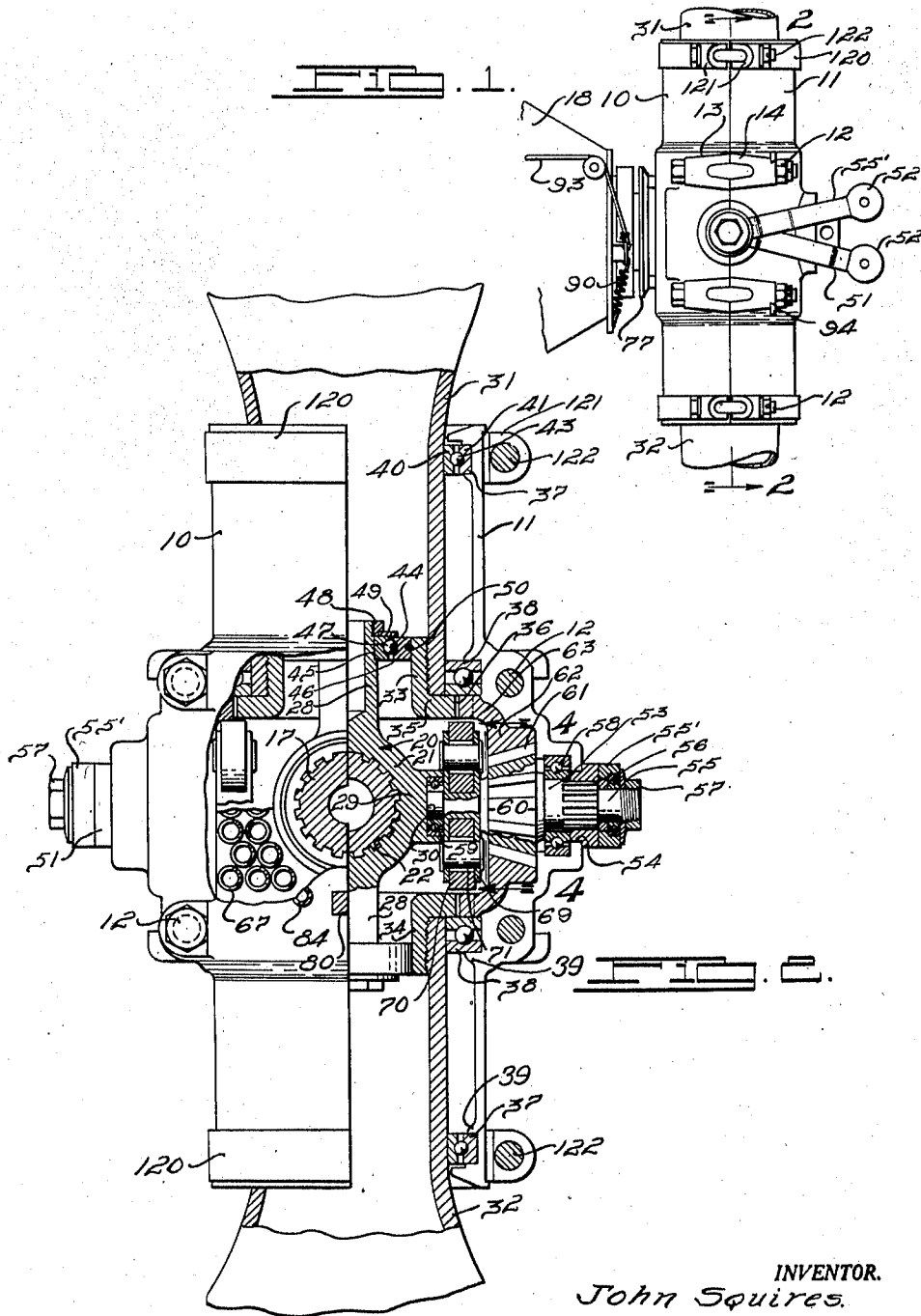
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2,118,574

AUTOMATIC PROPELLER

Filed Feb. 27, 1935

3 Sheets-Sheet 1



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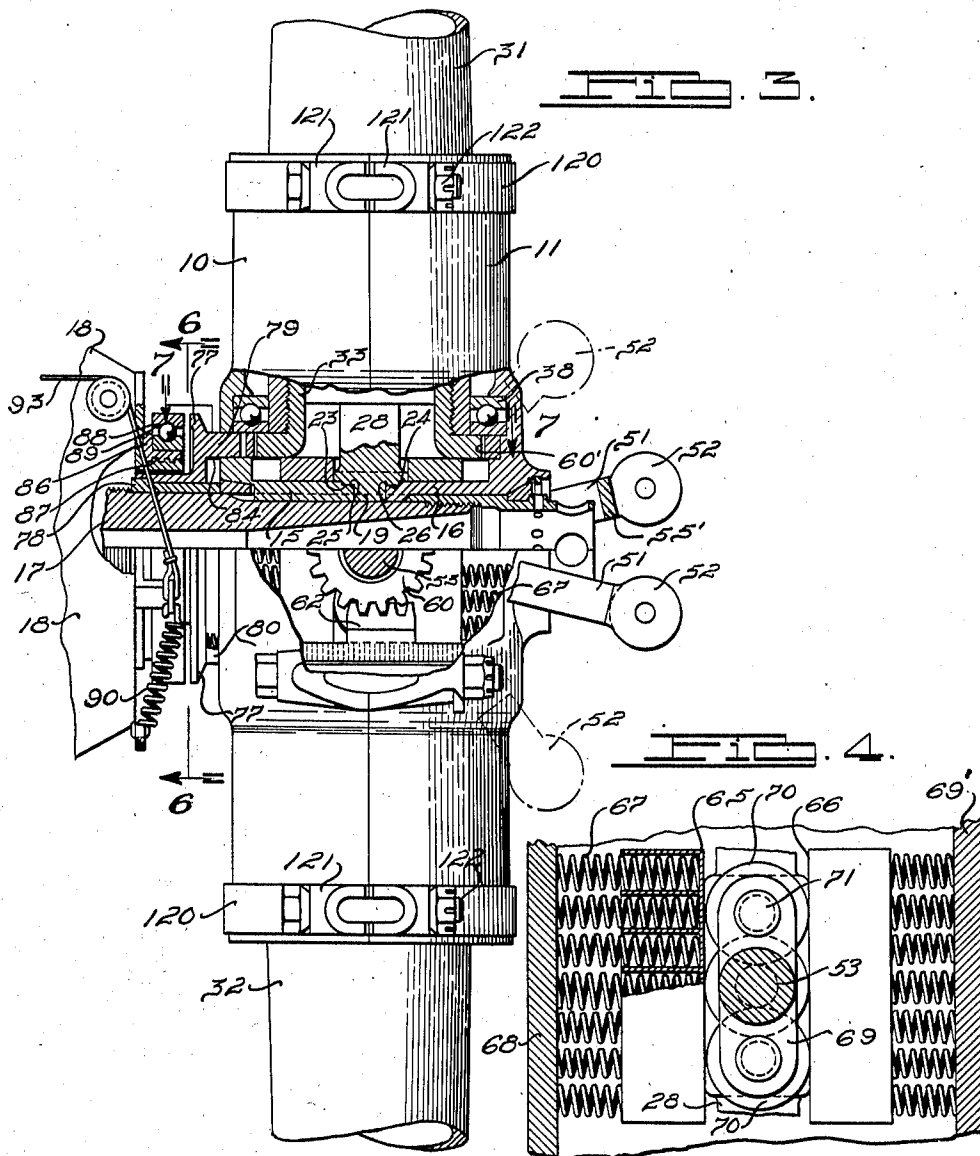
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

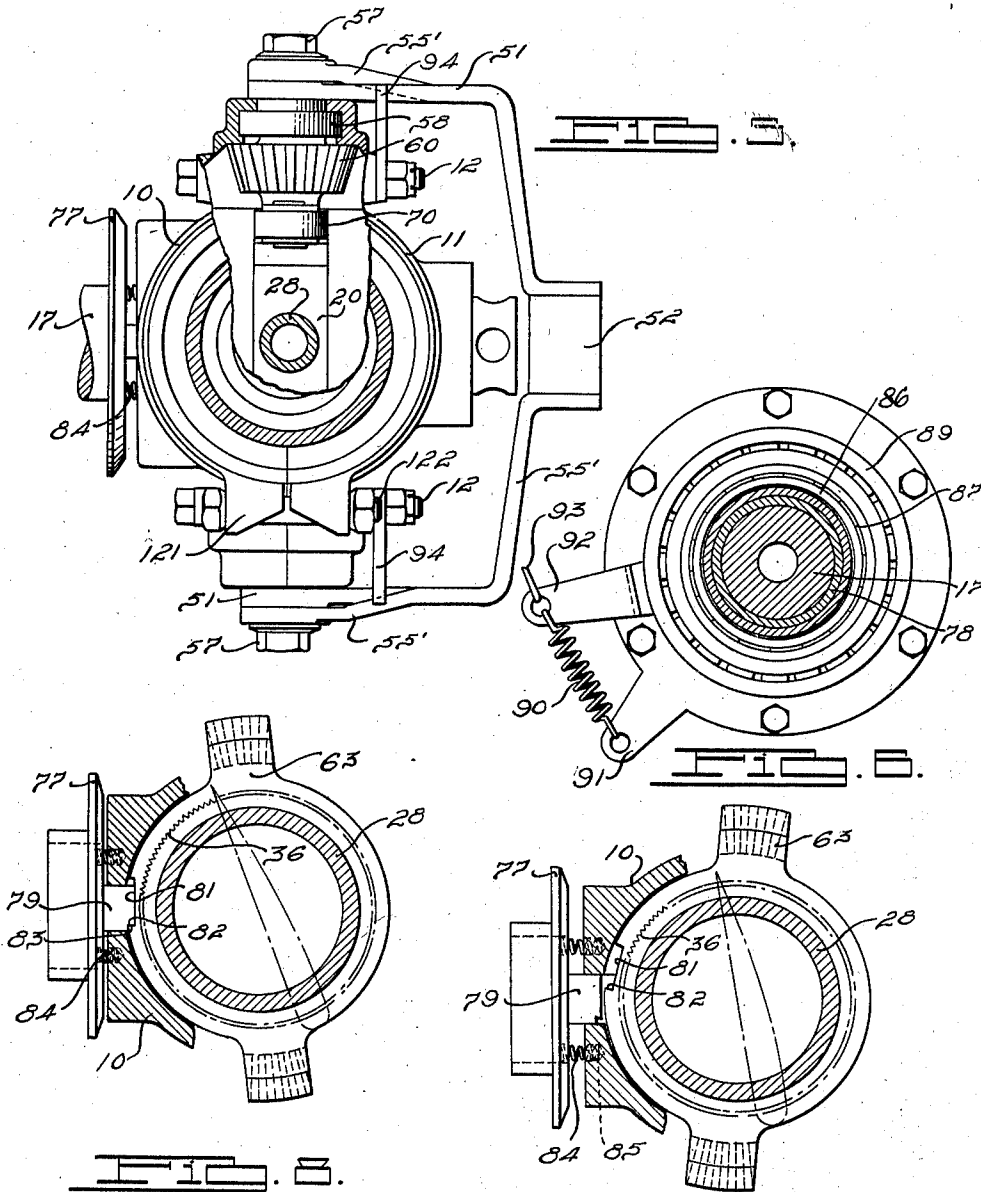


FIG. 7.

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AUTOMATIC PROPELLER

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Application February 27, 1935, Serial No. 8,440

12 Claims. (Cl. 170—162)

This invention relates to an improved variable pitch aircraft propeller and to an improved method of varying the pitch of the blades of the latter.

One of the main objects of the invention is to provide a propeller of this character which is automatically conditioned during operation to maintain the engine by which it is driven, at its full load developing speed during varying speeds of forward movement of an aircraft.

Another object of the invention is to provide apparatus for varying the pitch of the blades of the propeller through relatively wide limits from a predetermined minimum pitch to a predetermined maximum pitch within a comparatively small range of changes of speed of the propeller and which is adapted to maintain the blades at their minimum pitch, or at any intermediate pitch position, until the propeller speed reaches a relatively high value corresponding approximately to the rated full power speed of the engine by which it is driven.

Another object of the invention is to provide an improved centrifugally operable propeller blade pitch increasing mechanism and an improved method of varying the pitch of adjustable propeller blades.

A further object of the invention is to provide improved apparatus for yieldably urging the blades of the propeller toward their minimum pitch positions which is adapted to exert an initial relatively high resistance to increasing of the pitch of the blades from their minimum pitch positions without presenting an excessively high resistance to increase of the pitch from its minimum to its maximum pitch position by the centrifugal apparatus.

A still further object of the invention is to provide pitch reducing apparatus of the above character having resilient means which is subjected to a maximum amplitude of deflection per unit of increase of the propeller blades during their initial movement from their minimum pitch position and which is subjected to a gradually decreasing amplitude of deflection per unit of increase of the pitch of the blades during movement thereof from their minimum to their maximum pitch positions respectively.

A further object of the invention is to maintain resilient resistance having a relatively low effective build-up rate, to increase of the pitch of the blades of a propeller, so as to enable increase thereof from their minimum to their maximum pitch positions by centrifugal governor apparatus of comparatively low weight.

Other objects of the invention are to provide

improved means for articulating a rotatively mounted propeller blade and its pitch varying mechanism; to provide means of this character which is adapted to permit variation of the maximum and minimum pitch of the blades; and to provide means of this kind which is detachably securable to a propeller blade having a hollow root end portion without requiring formation of a radial flange thereon or otherwise disturbing the metal of the root end portion of the propeller.

Further objects of the invention are to provide improved means for rotatively supporting a propeller blade hub structure; to provide axially spaced internal and external bearing members for rotatably supporting a propeller blade having a hollow root end portion; to provide a support for the internal bearing members which is adapted to be concentrically positioned with respect to the rotative axis of the propeller by the propeller shaft and adapted to be maintained in axial alignment with the propeller blades by the sleeve of a propeller hub in which the propeller shaft is received; to provide improved internal bearing member supports of this character having diametrically opposite trunnions for supporting the internal bearings of opposite blades of a propeller; to provide a bearing support of this character which is adapted to accurately maintain the axis of rotation of the blades in perpendicular relationship to the axis of revolution thereof; to provide an internal bearing support of this kind which is adapted to serve as a support for some of the bearings in which parts of the pitch varying apparatus are journaled; to provide a common support for bearings of the variable pitch blades and bearings of the centrifugal pitch varying apparatus which is adapted to accurately maintain respective rotative axes of such parts in a predetermined relationship and to relieve the casing portion of the hub structure of stresses and force applied by the blades and their pitch varying mechanism by transmitting such forces and stresses directly to the propeller shaft upon which the bearing support is mounted; and to provide a support of this character which transmits some of the propeller shaft torque directly to the blades independently of the hub casing, thereby permitting hub casing structure of less weight than heretofore practical in commercial propeller structures.

A still further object of the invention is to provide improved resilient means and supporting structures therefor for urging the blades toward their minimum pitch position; to provide resilient means of this character which are symmetrically

arranged with respect to the axis of the propeller and which are constructed and arranged to permit the symmetrical disposition of substantially all the parts of the structure of the hub and blade pitch varying apparatus with respect to such axis; to provide opposed groups of such resilient elements which extend substantially parallel to the propeller shaft axis and which expand and contract in directions parallel to the propeller shaft axis whereby their action is not interfered with by centrifugal forces during operation of the propeller; and to provide pressure plates upon which the resilient elements act which are slidably mounted on the propeller shaft receiving sleeves of the hub structure in symmetrical relationship with respect to the propeller shaft axis for shifting movement axially of the propeller shaft.

An illustrative embodiment of the invention is shown in the accompanying drawings, in which:

Fig. 1 is a fragmentary elevational view of a propeller embodying my invention and diagrammatically illustrating in a fragmentary fashion the portion of the structure of an aircraft with which it is conventionally associated.

Fig. 2 is a fragmentary vertical sectional view of a propeller taken on the line 2—2 of Fig. 1 showing parts of the hub casing removed to disclose the underlying structure.

Fig. 3 is a side elevational view similar to Fig. 1, but on a larger scale and partially in section showing parts of the propeller hub removed to disclose the underlying structure.

Fig. 4 is a fragmentary vertical sectional view taken on the line 4—4 of Fig. 2.

Fig. 5 is a transverse sectional view of my improved propeller showing portions of the hub casing thereof broken away to disclose the underlying structure.

Fig. 6 is a vertical sectional view taken on the line 6—6 of Fig. 3.

Fig. 7 is a horizontal sectional view taken on the line 7—7 of Fig. 3 showing portions of the propeller blade locking mechanism and illustrating the latter in a released condition.

Fig. 8 is a view similar to Fig. 7, but showing the propeller blades in a locked position.

In the form shown, my improved propeller has a hub portion which includes a pair of complementary sections 10 and 11 that are firmly clamped together with their edges in abutting relationship by bolts 12 which extend through apertured bosses 13 and 14 on the hub sections 10 and 11, respectively. Integrally formed on the hub sections 10 and 11 are inwardly extending sleeves 15 and 16 for receiving a propeller shaft 17 that projects outwardly from a nose structure 18 of the engine of an aircraft. The propeller shaft 17 is splined in the sleeves 15 and 16 which terminate in spaced relation providing a recess 19 in which is received a support, generally designated by the numeral 20, having a ring-shaped central portion 21 provided with a splined aperture 22 for receiving the propeller shaft 17. The central collar 21 of the support 20 is provided with opposite shoulders 23 and 24 which are received on reduced outer peripheral portions 25 and 26 of the sleeves 15 and 16, respectively. Trunnions 28 integrally formed on the ring-shaped central portion 21 of the support extend longitudinally of the hub structure and are disposed in a plane normal to the axis of the propeller shaft. The support 20 is provided with diametrically opposite bosses 29 extending transversely of the hub structure and disposed in the above mentioned plane of the

trunnions 28. The trunnions 28 and bosses 29 are spaced apart arcuately by 90 degrees and the outer extremities of the bosses 29 are provided with recesses 30.

The respectively opposite longitudinal ends of the propeller hub are open for receiving rotatably adjustable propeller blades 31 and 32 which have open inner extremities in which collars 33 and 34, respectively, are threaded. Each collar has an outwardly extending radial flange 35 provided with a serrated outer periphery 36. The root end portion of each of the blades 31 and 32 is rotatably externally supported in one longitudinal end portion of the hub structure, respectively, by spaced external bearings 37 and 38, which are disposed between the outer periphery of the root end portions of the blades and the inner periphery of the hub structure and held at longitudinal locations of the hub by inwardly extending flanges 39. Each bearing element includes a pair of concentric race members 40 and 41 having registering grooves in which rolling contact elements comprising ball bearings 43 are disposed. The inner end portion of each blade is centered and internally rotatably supported by an internal bearing 44 comprising race members 45 interposed between the threaded collar of each respective blade and the trunnion 28 associated therewith. The bearing elements 45 and 46 are provided with registering grooves in which rolling contact elements comprising ball bearings 47 are disposed. The outer end portions of the hub sections 10 and 11 are releasably clamped together by split bands 120, each having apertured cleats 121 on their adjacent extremities in which bolts 122 are threaded.

The inner race member 45 for the internal bearing 44 is concentrically mounted on a reduced portion of the trunnion 28 and held against outward displacement therefrom by a lock nut 48 and a washer 49 extending over both race elements 45 and 46 and having an edge portion disposed between the nut 48 and the race element 45 as illustrated in Fig. 2. The outer race member 46 is received in a groove 50 formed in the threaded collar 33 and its lower side abuts a shoulder constituting the end wall of the groove. The construction provides a tie between each blade and the support 20 and enables the blades, during operation of the propeller, to be stabilized independently of the hub casing by the support 20 and propeller shaft 17 on which it is splined.

The internal bearings 44 are spaced axially from at least one series of external bearings and they cooperate with the trunnion 28 in maintaining the blades 31 and 32 in axial alignment with each other and in perpendicular relationship with the axis of the propeller shaft which coincides with the axis of rotation of the propeller. The support 20 which is splined on the propeller shaft 17 directly transmits some of the torque of the propeller shaft to the respective blades of the propeller and thereby relieves the hub casing of substantial torque rendering it possible to employ thinner and lighter walls in the hub casing. Various other forces applied by the blades during operation of the propeller are transmitted directly to the propeller shaft without subjecting the hub structure to such forces.

Centrifugal apparatus, responsive to rotation of the propeller, is provided for increasing the pitch of the blades. The centrifugal actuating apparatus includes a pair of angularly shaped arms 51 mounted for rotative movement about an axis extending substantially perpendicular to the axis

of rotation of the propeller and intersecting this axis. The outer end portion of each governor arm 51 is bent inwardly and provided with a weight 52 which is constrained to movement in the vertical plane of the propeller shaft axis and normally disposed in advance of the forwardmost end of the propeller shaft. Interposed between the blades and the centrifugal actuating apparatus is articulating means by which movement of the blades is produced. Each governor arm 51 is splined on a stub-shaft 53 of the articulating means which extends through an aperture 54 in the side wall of the hub casing and which is located in a 90 degree angular relation to the sockets of the hub casing in which the propeller blades are received. Formed on the outer end portion of each stub shaft 53 is a reduced boss 55 on which a reinforcing arm 55' is rotatably mounted by a bearing 56. The reinforcing arm 55' of each side of the hub structure is fixed to the weight 52 of the arm 51 of the opposite side of the hub, respectively, and each associated governor arm, weight and reinforcing arm together constitute a bail-like structure by which the movements of the respective weights are effectively confined to a predetermined course. Each reinforcing arm 55' and its corresponding governor arm 51 is detachably secured to the stub shaft 55 by a nut 57 threaded on the outer end portion of the boss 55. The intermediate portion of each stub shaft 53 is rotatively supported by a bearing 58 mounted in the aperture 54 of the hub casing and each stub shaft 53 is rotatively supported at its inner end by a bearing 59 mounted in the recess 30 of each laterally projecting boss 29 of the support 20. A beveled gear 60 is provided on the intermediate portion of each stub shaft 53. These beveled gears have gear teeth meshed with beveled gear teeth 61 of gear segments 62 carried by collars 63, one of which is associated with each blade of the propeller.

Each collar 63 has a pair of diametrically opposite gear segments 62 and is concentrically mounted on the radially extending flange 35 of the threaded collar 33. Formed on the inner periphery of each collar 63 are serrations 60' which interfit with the serrations 36 of the threaded collar 33. The gear segment-carrying collars 63 are detachably associated with the threaded collars of the propeller blades and they are adapted to facilitate selective predetermining of the maximum and minimum pitch of the blades. The gear segments 62 of the respective collars 63 are arranged in registering opposite relationship and registering gear segments are meshed with the teeth of the same beveled gear 60, thereby accurately synchronizing the rotative movements of the propeller blades relative to their hub structure.

The blades 31 and 32 are normally urged toward their minimum pitch positions which may be any select value but preferably 14 degrees, by suitable resilient means. In the form shown the blade pitch reducing mechanism includes a pair of cup-shaped pressure members 65 and 66 which are slidably mounted on the propeller shaft receiving sleeves 15 and 16, respectively, as shown in Fig. 3. These pressure members are shiftable axially of the propeller shaft and they are normally urged inwardly by groups of coil springs 67, one bearing between each pressure member 65 and 66 and the front and rear wall portions 68 and 69' of the hub casing, respectively. Inward movement of the pressure plates 65 and 66 is arrested by a pair of levers 69 one of which is

non-rotatably mounted on the inner end portion of each stub shaft 53. The levers 69 extend on respectively opposite sides of the axis of their associated stub shaft 53 and they are provided with bifurcated end portions between which rollers 70 are rotatably mounted on pins 71. The peripheries of the rollers contact with the adjacent faces of the pressure members 65 and 66 and the pressure members normally yieldably retain the levers 69 in the vertical position shown in Fig. 4 corresponding to the minimum pitch position of the blades. The springs 67 are symmetrically arranged with respect to the propeller axis and they expand and contract in directions substantially parallel thereto. For this reason the expansion and contraction of the springs is not interfered with by centrifugal forces during operation of the propeller. The pressure members 65 and 66 also have their weights symmetrically distributed with respect to the axis of the propeller and since they move axially of the propeller shaft, their operation is not influenced by centrifugal forces during rotation of the propeller. The rolling contact engagement between the peripheries of the rollers 70 and the pressure members 65 and 66 minimizes loss of energy by friction and insures the smooth action of the apparatus.

The diameters of the rollers 70 and the distances of their pivotal axes from the axis of the stub shaft 53 can, by virtue of the construction and arrangement of the blade pitch controlling apparatus, be predetermined to produce a desired variation of the build-up rate of the resistance offered to increase the pitch of the blade throughout a predetermined range of pitch changes. By reference to Fig. 4, it will be seen that during initial clockwise rotation of the lever 69 from its normal vertical position by the centrifugal arm 51 with which it is associated, the amplitude of the outward displacement of the pressure members 65 and 66, per unit of rotation of the lever 69, is of a maximum value for the horizontal component of the rotative movements of the end portions of the lever 69 is much greater than the vertical component of the movement thereof. As the lever 69 is rotated from its vertical position toward a horizontal position, the horizontal components of the movements of the end portions of the lever decrease and the vertical components of the movements thereof increase. Therefore, as the lever 69 approaches its limiting position of clockwise rotation, for example, the amplitude of outward displacement of the pressure members 65 and 66, per unit of arcuate movement of the lever, is at a minimum. Accordingly, the amplitude of outward displacement of the pressure members 65 and 66, per unit of arcuate movement of the lever 69, decreases from a maximum during initial movement of the lever from its vertical position to a minimum value as the lever approaches the limit of its movement from its vertical position.

It is recognized that the variation of the point of contact between the peripheries of the rollers and the side faces of the pressure members due to the rolling contact engagement therebetween tends to cause the amplitude of displacement of the pressure members, per unit of arcuate movement of the lever, to increase as the latter is turned from its vertical position toward its opposite limit of movement. The final effect of these two oppositely varying influences can, however, be definitely predetermined by properly predetermining the diameters of the rollers with respect

to the distances between the pivotal axes thereof and the pivotal axis of the lever on which they are mounted. The apparatus is preferably so constructed and arranged that the springs 67 are subjected to a greater amplitude of deflection per unit of initial rotation of the lever from its normal position than during subsequent rotation of the lever. This results in the resilient exertion upon the blades of an increasing pitch reducing force having a gradually decreasing build up rate.

When the blade-controlling apparatus is conditioned as illustrated in the drawings, to produce a maximum amplitude of deflection per unit of increase of the pitch of the propeller blades during their initial movement from their minimum pitch position and a gradually decreasing amplitude of deflection per unit of increase of the pitch of the blade during subsequent pitch adjustment of the blades, the blades may be held in their minimum pitch positions by an initial compression of the resilient means until the speed of rotation of the propeller has reached a comparatively high value, corresponding, for example, to the rated full power speed of the engine by which the propeller is driven. This can be conveniently accomplished without requiring the utilization of an excessive amount of weight in the centrifugal governor control apparatus in order to ultimately advance the blade pitch to the maximum value. When the apparatus which resiliently urges the blades toward their minimum pitch positions is provided with effective build-up rate which varies in the above manner during movement of the blades from their minimum pitch positions toward their maximum pitch positions, the pitch of the blades may readily be varied throughout a relatively wide range of pitch values within a comparatively small range of changes of speed of the propeller.

During cruising flight of an aircraft, it is sometimes highly desirable to retain the blades at a given pitch position irrespective of the operating speed of the propeller. My improved propeller is provided with locking mechanism by which this may be conveniently accomplished at the will of the operator. In the form shown the locking apparatus includes a collar 77 which is mounted on a sleeve 78. The sleeve 78 is concentrically mounted on the propeller shaft 17 adjacent the rear side of the propeller hub and the collar 77 is adapted to shift axially of the propeller shaft and relative to the sleeve 78. The collar 77 has integral lugs 79 and 80 which extend through apertures in the hub and are adapted to seat in notches 81 formed in the periphery of the flanges 35 of the collars 33 and 34 threaded on the blades 31 and 32, respectively. The notches 81 are somewhat wider than the ends of the lugs 79 and 80 and they are provided with an undercut wall 82 on which abuts against an undercut edge 83 on the lugs so as to hold the lugs against withdrawal from the notches until the propeller blades are turned in a clockwise direction by augmenting the speed of rotation of the propeller momentarily. The collar 77 is constantly urged away from the hub by springs 84 which are seated in recesses 85 formed in the hub and which bear outwardly upon the collar 77, as illustrated in Fig. 7.

Actuating apparatus is provided for moving the collar 77 outwardly with respect to the nose structure of the engine. This actuating apparatus moves a carrier 86 which is threaded on the nose structure of the engine by threads 87 having a

substantially large pitch. Mounted on the carrier 86 is a ball race 88 having an outer race element 89 which is adapted to bear against the collar 77 when the carrier is screwed outwardly so as to urge the collar away from the nose structure 18 of the engine. The carrier 86 is normally held in retracted position by a coil spring 90 which is attached at one end to a fixed arm 91, and at its other end to an arm 92 which is integrally formed with the collar. A wire or cord 93 is secured to the arm 92 of the carrier and extended rearwardly into the cock pit of the aircraft (not shown). When it is desired to lock the blades in their cruising pitch positions, as a matter of illustration, 18 degrees, the wire 93 is pulled upon so as to urge the carrier 86 to turn in a clockwise direction as viewed in Fig. 6. The engine is then varied in its speed until the blade adjusting mechanism heretofore described turns the propeller blades sufficiently to bring the notches 81 into alignment with the lugs 79 and 80, at which time the pull on the cord 93 tending to turn the carrier 86 causes the carrier to turn and move the collar 77 forwardly, thus projecting the lugs 79 and 80 into the notches 81.

When this occurs, if the engine speed is now reduced, the blade adjusting mechanism will operate to reduce the pitch of the blade and cause engagement of the undercut walls 82 on the blade flanges and the undercut edges 83 of the lugs, thus preventing further decrease in the pitch of the blades and holding the lugs 79 and 80 from pulling out of the notches 81 under the force of the spring 84 without any further effort on the part of the operator. The pull on the wire may now be released on the part of the operator and the spring 90 will return the carrier 86 to its retracted position. The engine may now be operated at cruising speed with the propeller maintained at a constant predetermined pitch favorable for cruising. When it is again desired to render the automatic blade adjusting apparatus effective, all that is required on the part of the operator is to speed up the engine sufficiently to cause the blade adjusting mechanism to turn the blades sufficiently to disengage the undercut portions or the lugs 79 and 80 from the undercut walls of the notches 81 and the spring 84 will then return the collar 77 and lugs 79 and 80 to inoperative position.

The springs 67 are normally placed under a sufficient initial compression to retain the blades in their minimum pitch position during operation of the propeller below the rated full power operating speed of the engine corresponding, for example, to a propeller speed of 2,175 R. P. M. When the operating speed of the propeller exceeds this value the governor arm 51 and weight 52 attached thereto are rotated by centrifugal action into the plane of rotation of the propeller thereby increasing the pitch of the blade against the action of the spring 67 until the blades reach their maximum positions of, for example, 22 degrees. Further increasing of the pitch of the blades is prevented by engagement of the governor arm 51 with suitable stops 94 provided on the hub structure. The blade controlling apparatus is preferably calibrated to bring the blades to their maximum pitch when the operating speed of the propeller is substantially 2,225 R. P. M. The varying effective build-up rate of the yielding, resilient resistance to decreasing of the pitch of the blades allows variation of the pitch thereof throughout an 8 degree range within a range of 50 R. P. M. and enables holding the

blades at their minimum pitch positions until an operating speed of 2175 R. P. M. is attained. All this is accomplished without the use of excessively heavy centrifugal governor arms.

Although but one specific embodiment of the present invention has been illustrated and described in detail, it will be apparent to those skilled in the art that various modifications, omissions, additions and substitutions may be made therein without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

I claim:

1. In an aircraft including an engine, a propeller operable by said engine including a rotatably adjustable blade, centrifugal apparatus for increasing the pitch of said blade, and mechanism for yieldably urging said blade toward its minimum pitch position including resilient means under an initial compression for holding said blade against movement from its minimum pitch position until substantially the rated full power operating speed of said engine is attained, said mechanism including opposed pressure members and a rotatable member having end portions on opposite sides of its axis, each co-acting with one of said pressure members respectively and being so constructed and arranged as to subject said resilient means to a substantially gradually decreasing amplitude of deflection per unit of increase of the pitch of said blade during movement thereof from a minimum to a maximum pitch position.

2. In a propeller including a hub structure and a rotatably adjustable blade, mechanism for varying the pitch of said blade including actuating apparatus, means for articulating said actuating apparatus and said blade including a rotatable member, and mechanism for yieldably opposing variation of the pitch of said blade by said actuating apparatus including a lever non-rotatably mounted on said rotatable member having a roller thereon and a shiftable resiliently urged element in rolling contact with said roller for yieldably resisting rotation of said member, said lever and shiftable element being so constructed and arranged that the latter will be subjected to its maximum amplitude of displacement per unit of variation of said member from its minimum pitch position and to a decreasing amplitude of deflection thereafter.

3. In a propeller including a hub structure and rotatably adjustable blades, mechanism for increasing the pitch of said blades including actuating apparatus, means for articulating said actuating apparatus and said blades including a rotatable member having a lever extending on respectively opposite sides of its axis, a pair of pressure plates slidably mounted on said hub structure, one on each side of said lever and coacting with each end portion thereof respectively for yieldably resisting rotation of said member and increase of the pitch of said blades, and springs urging each pressure plate toward said lever.

4. In a propeller including a hub portion and a rotatably adjustable blade, mechanism for increasing the pitch of said blade including actuating apparatus, means for articulating said actuating apparatus and said blade including a rotatable member having abutment faces thereon, opposed pressure plates slidably mounted on said hub structure each engageable with one of said abutment faces respectively for yieldably resisting rotation of said member and increase of the

pitch of said blade, and resilient means for urging said pressure plates toward said abutment faces.

5. A propeller including a hub portion having a passage for receiving a propeller shaft and a rotatably adjustable blade, mechanism for increasing the pitch of said blade including actuating apparatus, means for articulating said actuating apparatus and said blade including a rotatable member having an axis substantially normal to the axis of said shaft receiving passage and having abutment faces projecting outwardly from its axis on opposite sides thereof, and means co-acting with said outwardly projecting abutment faces for yieldably resisting rotation of said member and increase of the pitch of said blade including opposed pressure plates, slidably axially of said passage and springs urging said pressure plates toward said abutment faces.

6. In a propeller including a hub portion and a rotatably adjustable blade, mechanism for increasing the pitch of said blade including actuating apparatus, means for articulating said actuating apparatus and said blade including a rotatable member, a roller journaled on said rotatable member having an axis spaced from the axis thereof, and means for yieldably resisting rotation of said member and increase of the pitch of said blade including a pressure element bearing upon the periphery of said roller and a resilient element urging said pressure element toward said roller, the diameter of said roller and the distance of the axis thereof from the axis of said rotatable member being so proportioned as to impart to said pressure element a gradually decreasing amplitude of movement per unit of increase of said pitch of said blade from its minimum pitch position to its maximum pitch position.

7. In an aircraft including an engine, a propeller operable by said engine including a hub structure and a rotatably adjustable blade, mechanism for increasing the pitch of said blade including centrifugal actuating apparatus responsive to the speed of said propeller, and means for articulating the latter and said blade, said articulating apparatus including a rotatable member, a roller journaled on said rotatable member having its axis spaced from the axis of the latter, and means for yieldably resisting rotation of said member and increase of the pitch of said blade including a pressure element bearing upon the periphery of said roller and a resilient element urging said pressure element toward said roller and under an initial compression for retaining said blade in its minimum pitch position until the rated full power speed of said engine is attained, the diameter of said roller and the distance of the axis thereof from the axis of said rotatable member being so proportioned that increase of the pitch of said blade throughout a comparatively wide range occurs within a relatively small range of speeds of said propeller.

8. A propeller including a hub, having a blade receiving socket and having a pair of spaced propeller shaft receiving sleeves, a blade having a hollow end portion disposed in said socket, a support in said hub having a body portion disposed between and free from direct fixed attachment to said sleeves and provided with an opening for receiving a propeller shaft, and a bearing between said support and the internal wall of the hollow end portion of said blade.

9. A propeller including a hub casing having a shaft receiving sleeve and a socket therein, a

- blade detachably mounted on said hub casing, and means for directly connecting said blade and shaft independently of said hub casing including a support free from unitary rotative fixation with respect to and carried by said sleeve, said support being non-rotatably securable to said shaft and adapted to apply some of the torque of the latter directly upon said blade independently of said hub casing.
- 10 10. A propeller and propeller shaft assembly including a propeller hub casing having spaced aligned sleeves therein for receiving a propeller shaft, the adjacent end of said sleeve having circumferentially reduced portions, a propeller shaft in said sleeves, a propeller blade adjustably mounted on said hub casing having a hollow end portion, a support disposed between said sleeves and mounted on the circumferentially reduced end portions thereof, said support being non-rotatably securable to said shaft, and a bearing element coacting between said support and the inner periphery of the hollow end portion of said blade for journaling the latter.
- 25 11. A propeller including a hub casing having a propeller shaft receiving sleeve therein, a pair of blades adjustably mounted on said hub casing, apparatus responsive to the speed of rotation of said propeller for increasing the pitch of said blades including means for synchronizing the movement of said blades relative to said hub casing, and mechanism for yieldably resisting increase of the pitch of said blades including a pair of pressure members each mounted on one end section of said sleeve and shiftable thereon in opposite directions axially of said shaft and including resilient elements disposed concentrically about said sleeve and bearing between each of said pressure members and one of a pair of opposite walls of said hub casing respectively normally urging said pressure members toward each other.
- 15 12. A propeller including a hub casing having a propeller shaft receiving sleeve therein, a blade adjustably mounted on said hub, apparatus for varying the pitch of the blade in one direction, and mechanism for yieldably resisting said variation including a pair of pressure members mounted on the outer periphery of said sleeve and shiftable axially relative thereto and including resilient means concentrically disposed with respect to said sleeve and shaft and bearing in opposite directions between opposite sides of said hub casing and acting upon said pressure members.

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