

July 16, 1935.

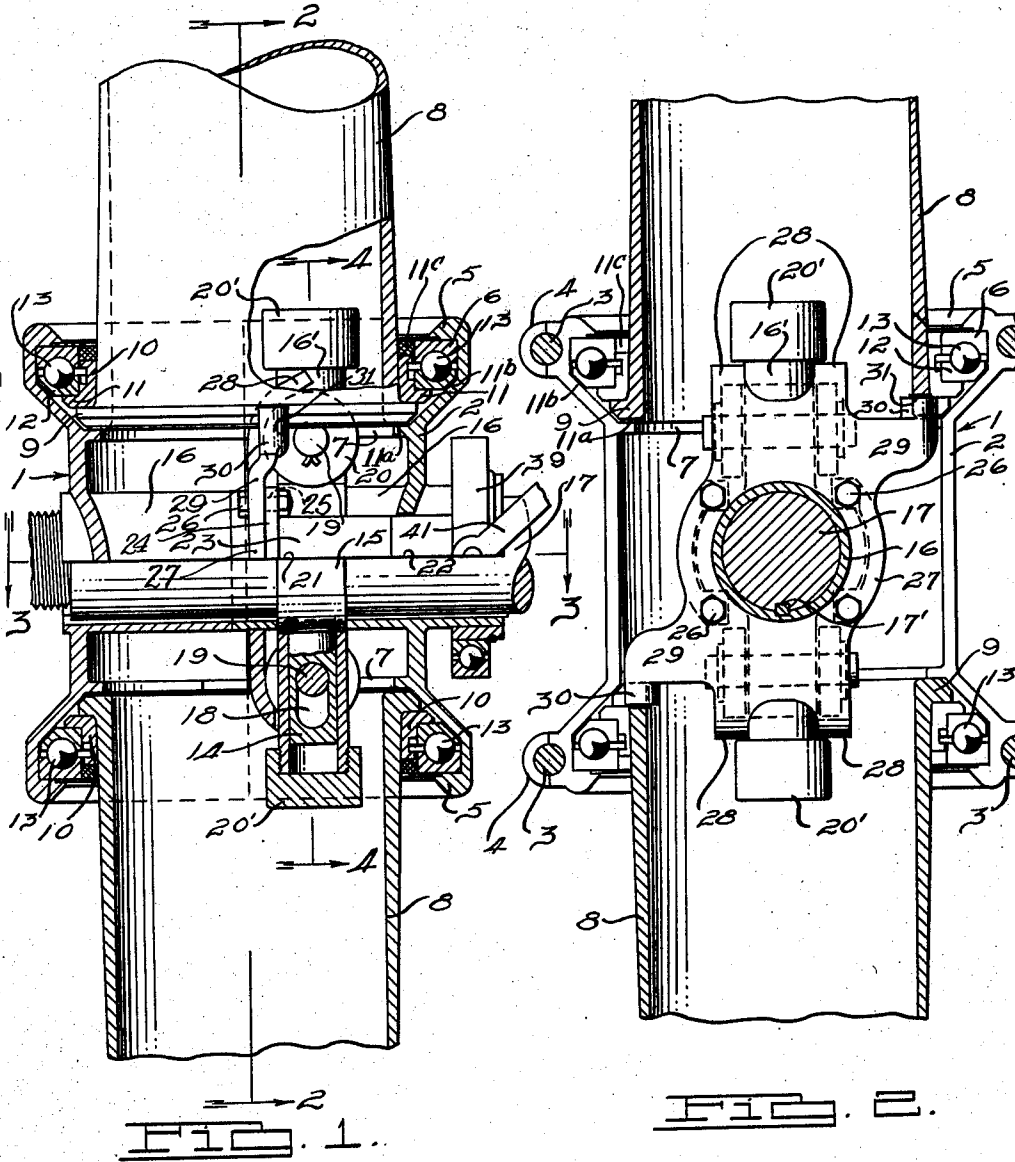
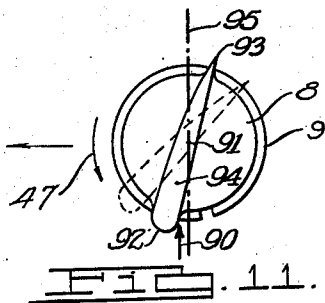
J. SQUIRES

2,008,191

PITCH ADJUSTING MEANS FOR PROPELLERS

Filed Oct. 7, 1931

4 Sheets-Sheet 1



INVENTOR
John Squires.
BY
Harness, Dickey, Pierce & Hann
ATTORNEYS.

July 16, 1935.

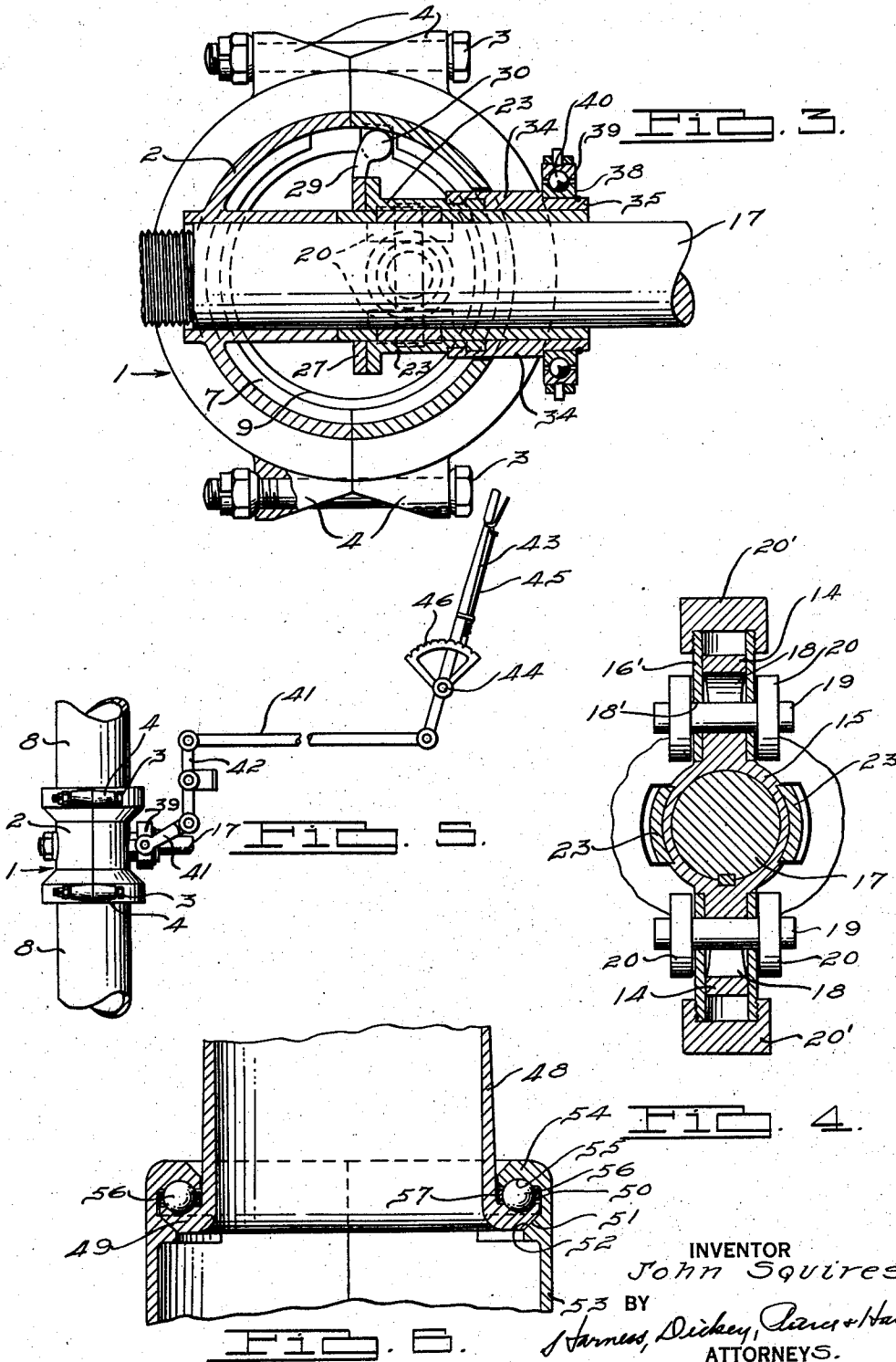
J. SQUIRES

2,008,191

PITCH ADJUSTING MEANS FOR PROPELLERS

Filed Oct. 7, 1931

4 Sheets-Sheet 2



July 16, 1935.

J. SQUIRES

2,008,191

PITCH ADJUSTING MEANS FOR PROPELLERS

Filed Oct. 7, 1931

4 Sheets-Sheet 3

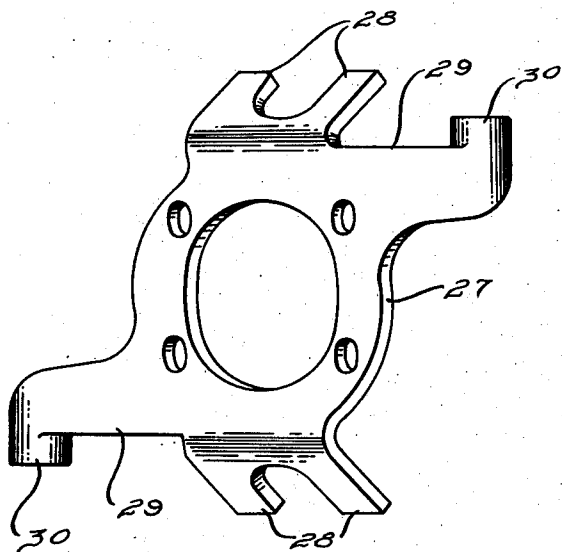


FIG. 8.

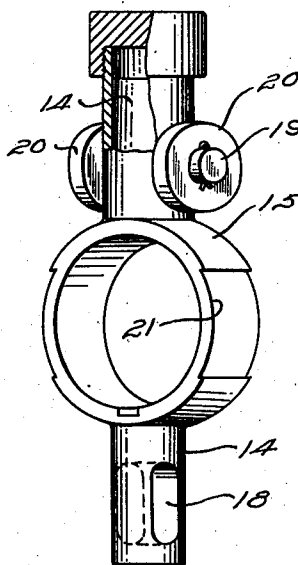


FIG. 7.

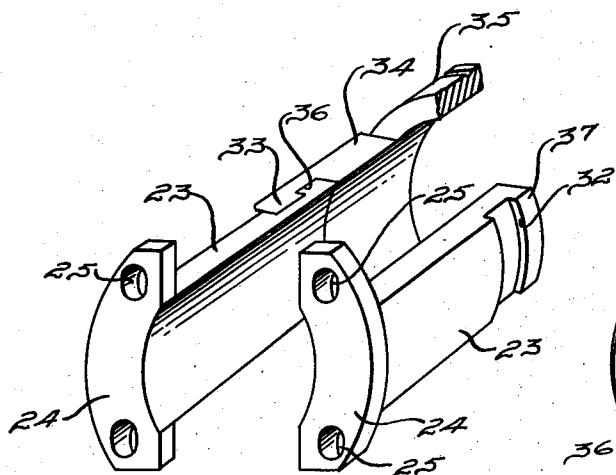


FIG. 9.

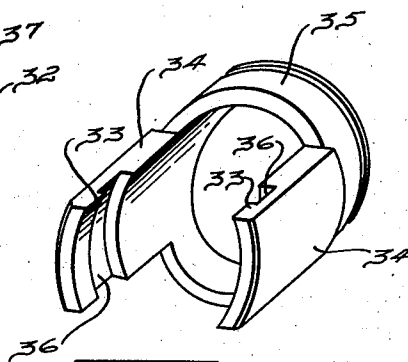


FIG. 10.

INVENTOR
John Squires.

BY
Harnes, Dickey, Pierce & Hann
ATTORNEYS.

July 16, 1935.

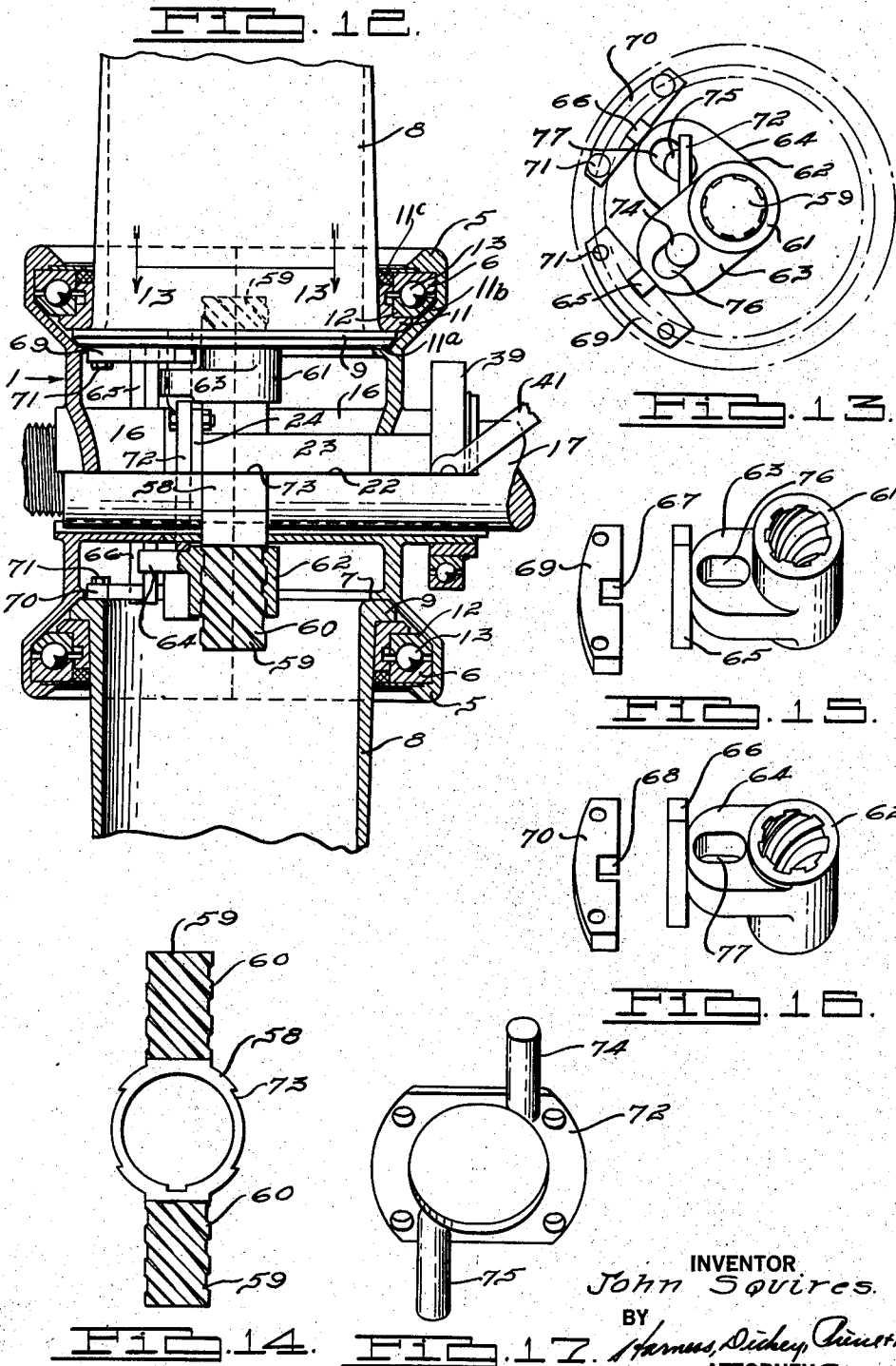
J. SQUIRES

2,008,191

PITCH ADJUSTING MEANS FOR PROPELLERS

Filed Oct. 7, 1931

4 Sheets-Sheet 4



INVENTOR
John Squires.

BY

Harmus, Dickey, Priest & Hand
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,008,191

PITCH ADJUSTING MEANS FOR
PROPELLERS

John Squires, Hagerstown, Md.

Application October 7, 1931, Serial No. 567,340

10 Claims. (Cl. 170—163)

This invention relates to an improved aircraft propeller of the type which has blades that are adjustable in pitch during operation of the propeller.

5 Propellers of this character generally include tubular blades which are received in sockets of a hub that is secured to a propeller shaft. When a considerable length of the root end portion of each blade is extended into a hub socket and ro-
10 tatably supported by spaced bearings, one located at the inner flanged extremity of each blade which engaged the sides of the socket, and the other lo-
15 cated in close proximity to a flange on the outer extremity of the socket which engages the side of the blade the resulting arrangement produces a rigid construction which firmly restrains the
20 blades from flexure under the centrifugal forces created during high speed rotation of the propeller, developing internal strains in the blades which result in their untimely failure.

Rotational adjustments of the blades to vary their pitch during operation are resisted in jour-
5 nal mountings of this kind by the frictional engagement between the sides of the sockets, blades and their respective flanges. Even greater oppo-
15 sition to turning of the blades toward increased pitch positions is created by the centrifugal action upon the blades which forcefully urges them toward zero pitch positions during operation of
20 the propeller. This action results from the tendency of the centers of mass of the blades to move into the plane of rotation of the propeller and it is opposed in part by the effect of wind pressure on the blades which creates aerodynamic
25 moments that urge the blades toward increased pitch positions. The centrifugal moment exerted on the blades normally exceeds the aerodynamic moment exerted thereon by a substantial amount, hereinafter called the torque differential.

30 The main objects of the invention are to provide improved structure for rotatably supporting a propeller blade in a socket of a hub which is adapted to hold the sides of the blade from fric-
35 tional engagement with the walls of said socket, to provide means of this kind which contacts with the root end portion of a blade at a single loca-
40 tion so as to prevent the creation of objectionable internal strains in the blade and to permit substantially unrestrained flexure of the entire length thereof under the centrifugal forces to which it is
45 subjected in operation; to provide a rolling contact bearing in a rotatable supporting structure of this kind which is adapted to hold the flanged extremity of the root end portion of the blade
50 against outward displacement from the hub

socket; to provide a seat in the hub socket for receiving the inner side face of the flange of the blade so as to prevent inward movement of the blade, and to provide sufficient clearance between
5 said seat and the side of the flange which it receives to allow the flange to be held out of contact with the seat by the centrifugal forces that are created during high speed operation of the propeller.

Further objects of the invention are to pro-
10 vide rotatable propeller blades in a propeller which, during operation, are normally urged toward increased pitch positions by the turning influence of wind pressure and which are urged
15 with a substantially greater force toward zero pitch position by the centrifugal moment acting thereon; to provide apparatus which is operable by centrifugal action during rotation of the propeller for opposing the torque differential of the
20 centrifugal and aerodynamic moments that tends to reduce the pitch of the blades; to provide means of this kind which may be conditioned during its construction to equalize the torque dif-
25 ferential, to exceed it or to be predominated by the torque differential; to provide manual control apparatus for varying the pitch of the blades during operation of the propeller which requires
30 only the application of slight force to either increase or decrease the pitch when the opposing forces of the centrifugal apparatus and the torque differential acting upon the blades are substan-
35 tially equalized; to provide control apparatus of this kind which is adapted to releasably hold the blades against displacement from an adjusted position when the torque differential of the cen-
40 trifugal and aerodynamic moments and the opposed turning effects of the centrifugal apparatus are unequalized, so as to allow the blades to be turned automatically by the force which pre-
45 dominates; and to provide manual control apparatus which is adapted to vary the pitch of the blades against the predominating force when de-
50 sired.

An illustrative embodiment of my invention is shown in which:

Figure 1 is a fragmentary vertical section of a propeller taken longitudinally of the propeller shaft.

Figure 2 is a vertical section taken on the line 2—2 of Fig. 1.

Figure 3 is a transverse horizontal section taken on the line 3—3 of Figure 1.

Fig. 4 is a vertical section of a centrifugal actuating unit embodied in my improved propeller and taken on the line 4—4 of Fig. 1.

Fig. 5 is a fragmentary side elevation of an adjustable propeller, diagrammatically illustrating control apparatus for varying the pitch of propeller blades.

Fig. 6 is a fragmentary vertical section of an adjustable propeller which has a modified rotatable blade supporting structure.

Fig. 7 is a perspective view showing, partly in section, a centrifugal actuating unit for turning a propeller blade in one direction to change its pitch.

Fig. 8 is a perspective view showing somewhat in detail, the element upon which the unit illustrated in Fig. 7 acts.

Fig. 9 is a fragmentary perspective view of parts of the manual control apparatus.

Fig. 10 is a perspective view showing the broken part of the control apparatus, illustrated in Fig. 9, in detail.

Fig. 11 is an end elevation of my improved adjustable propeller illustrating in dotted and full lines, respectively, two alternative positions of the blade.

Fig. 12 is a fragmentary vertical side elevation of an adjustable propeller embodying a modified embodiment of the invention taken longitudinally of the propeller shaft.

Fig. 13 is a plan view of the propeller hub taken internally of a tubular propeller blade on the line 13-13 of Fig. 12.

Fig. 14 is a side elevation of the threaded, radially extending member, shown in Fig. 12, which constitutes part of the centrifugal actuating unit.

Fig. 15 is a perspective view of the upper nut or inertia element which is supported on the threaded member.

Fig. 16 is a view similar to Fig. 15 showing the nut of the lower end of the threaded member.

Fig. 17 is a perspective view showing in detail, a part of manually operable apparatus for varying the pitch of the propeller blades.

In the form shown in Figs. 1 to 5, inclusive, my improved propeller has a hub 1 which includes a cylindrical casing 2 formed of two semi-cylindrical sections. These sections are clamped together by bolts 3 which extend through flanges 4 on the outer periphery of the sections in the manner shown in Fig. 3. The respectively opposite ends of the casing 2 each have an inwardly extending flange 5 against which is seated an internal ball race 6. Formed in the interior of the casing 2, in spaced relation to each end flange 5 is an inwardly extending flange or internal seat 7 for receiving the extremity of a propeller blade 8. The propeller blade 8 has a root end portion of tubular shape on which is provided a radial end flange 9. Surrounding the inner portion of the root end of the propeller is a split ring 10 which is located adjacent the flange 9 of the blade. This ring lies within the inner diameter of the ball race 6 and it has a radial flange or lip 11 on which a ball race 12 is seated. The ball race 12 cooperates with the ball race 6 in retaining a series of ball bearings 13 in position to rotatably support the propeller blade 8. These ball race members are provided with registering grooves of partial circular cross section for receiving ball bearings 13 having substantially the same radius of curvature as the grooves.

The propeller blade 8 is secured against outward displacement from the hub by the internal flange 5 thereof and it is prevented from moving inwardly with respect to the hub by the internal seat 7. The split ring 10 and lower ball race 12

prevent the sides of the propeller blade from contracting with or otherwise frictionally engaging any of the structure of the hub and the seat 7 is located at a sufficient distance from the flange 5 to provide clearance 11a between the seat and the extremity of the blade when the latter is urged outwardly by centrifugal force during operation of the propeller. Clearance spaces 11b and 11c are also provided between the ball race 12 of the blade and the inner periphery of the socket, and between the ball race 6 of the socket and the outer periphery of the blade respectively. With this construction, rotation of the blades 8 is not resisted by frictional engagement of the blade with any of the structure by which it is supported with the exception of the bearing unit which is constructed to minimize friction.

The bearing unit constitutes the sole deterrent to both outward and sidewise movements of the blades relative to the sockets in the hub in which the blade is received and since this bearing unit embraces only a limited extent of the length of the blade at the extreme end portion thereof, the entire length of the blade is free to flex under the centrifugal forces to which it is subjected during operation. This construction obviates the creation of internal strains which have heretofore been developed in the root end portions of blades that are supported at longitudinally spaced locations.

When propellers having rotatably mounted blades of the above type are operated, the wind pressure develops an aerodynamic moment which tends to rotate the blades toward increased pitch positions. The centrifugal action upon the centers of mass of the blades which tends to move the centers of mass into the plane of rotation of the propeller, urges the blades toward positions of reduced pitch with a substantially greater force than the opposing force of the wind pressure and creates a powerful torque differential which must be overcome in order to increase the pitch of the blades.

The blade adjusting apparatus shown in the drawings includes a centrifugal unit for opposing the pitch reducing effect of the torque differential of the aerodynamic and centrifugal moments. This apparatus also includes manual control mechanism for varying the pitch of the blades against either the normal torque differential or the opposing influence of the centrifugal unit. The centrifugal unit may be constructed so as to predominate over the pitch reducing effect of the torque differential and in this case manual force is required to decrease the pitch of the blade during operation of the propeller. If desired, the centrifugal apparatus may be constructed so as to apply a torsional force of less intensity than that of the normal torque differential and in this event application of manual force by the control mechanism is required to increase the pitch of the blades. The blades and the centrifugal means may also be constructed so as to produce torsional forces of equal intensity to urge the blades about their axes in respectively opposite directions. With this construction, manual control apparatus is relied upon to apply additional force in rotating the blades in each direction and in all of these cases the manual control apparatus includes structure for releasably holding the blade in an adjusted position.

In the form shown in Figs. 1 to 5, inclusive the centrifugal actuating unit includes a pair of posts 14 which are integrally formed on a collar 15 that is located between sleeves 16 provided in the

hub 1 for receiving the propeller shaft 17. Each post extends radially from the axis of rotation of the hub 1 into the interior of the root end portion of one propeller blade 8. Formed in each post 14 is an elongated slot 18 in which a pin 19 is slidably mounted. The pin 19 is provided on its respectively opposite end portions with weights or inertia elements 20 which are cylindrical in form. The collar 15 has an internal bore which is equal in size to the bores in the sleeves 16 and it also receives the propeller shaft 17 to which it is secured against rotation by a spline 17'. Slidably mounted on each post 14 is a sleeve 16' having apertures 18' for receiving the pins 19 and including a weighted detachable head cap 20'. The sleeve 16' and head cap 20' also urge the pin 19 and weight 20 outwardly during rotation of the propeller.

Slidably mounted in registering grooves 21 and 22 in the sides of the collar 15 and right sleeve 16, as viewed in Fig. 1, are bars 23 which are provided at their left extremities with flanges 24 having spaced apertures 25. These flanges are rigidly secured by bolts 26 to an actuating member or plate 27, shown in detail in Fig. 8. The plate 27 is shiftably mounted on the left sleeve 16 in which the propeller shaft is received and it is provided on each respectively opposite end with a pair of inclined, spaced fingers 28 which extend above the weights 20, as shown in Fig. 1. The actuating member or plate 27 also includes a pair of misaligned arms 29 which extend outwardly from its respectively opposite sides. Formed on the extremities of each arm 29 is a lug or boss 30 which is received in a recess 31 provided in the flanges 11 of the propeller blades. As this plate is shifted longitudinally of the propeller shaft 17, it rotates the blades 8 in respectively opposite directions.

The outer extremities of the slidable bars 23 have grooves 32 in their outer peripheries for receiving tongues 33 on the ends of arms 34 of a collar 35 shown in detail in Fig. 9. The arms 34 of the collar 35 are provided with internal grooves 36 for receiving tongues 37 on the outer extremities of the slidable bars 23. The collar 35 is slidably mounted on the propeller shaft receiving sleeve 16 of the right side of the hub 1, as illustrated in Fig. 3 and it is adapted to move the plate 27 inwardly and outwardly so as to rotate the propeller blades in respectively opposite directions.

The shiftable collar 35 is provided on its external end with a pair of ball race 38 and 39 between which are located a ball bearing 40. The outer ball race 39 constitutes a slip ring member which is operatively connected to manual control apparatus by a series of links and levers 41 and 42, respectively. The series of links and levers includes a manual operating lever 43 which is pivoted at 44 and preferably located in the fuselage of an aircraft within convenient reach of the operator. This operating lever has a spring pressed detent 45 which cooperates with a notched segment 46 in holding the control apparatus against displacement from an adjusted position so as to prevent unintended rotation of the propeller blades and varying of their pitch under the action of the wind pressure and the centrifugal actuating member.

In operation, as the propeller is rotated the force resulting from the air pressure acting in the direction of the arrow 90 on the portion of the face of the blade between the axis 91 of the blade and leading edge 92 thereof exceeds the

force derived from the air pressure acting upon the portion of the face of the blade between the axis and the trailing edge 93, as illustrated in Fig. 11. Thus the blade is urged in a clockwise direction toward an increased pitch position by the aerodynamic action to which it is subjected during rotation of the propeller. The center of mass 94 of the blade tends to swing into the plane of rotation of the propeller, thereby urging the blade in a counter-clockwise direction toward a neutral pitch position. The centrifugal action exceeds the aerodynamic action and therefore the torque differential of the wind pressure on the blades and the moments exerted thereon by centrifugal action tends to turn them in the direction of the arrow 47 in Figure 11 with a substantially uniform and ascertainable force. The centrifugal action on the discs 20 and weighted heads 20' move the discs outwardly on the posts 14. The discs bear upon the bifurcated fingers 28 and cam the shiftable plate 27 to the left, as viewed in Figure 1. The bosses 30 of the shiftable plate 27 turn the upper propeller blade in a clockwise direction and the lower propeller in an opposite direction, as viewed from above Fig. 1, so as to oppose the effect of the torque differential on the blades. The intensity of the action of the centrifugal unit may be conveniently varied by removing the threaded heads 20' and replacing them by similar members of various weights. In this manner the centrifugal apparatus may be conditioned to either equalize the effect of the above torque differential, to exceed it, or to be predominated by the effect of the torque differential. When the centrifugal apparatus is conditioned to overcome the pitch reducing effect of the above torque differential at one speed it urges the blade toward an increased pitch position at all operating speeds of the propeller for the effect of a change in speed of the propeller, upon the pitch increasing centrifugal apparatus is proportional to the effect of such a change upon the pitch reducing torque differential and therefore if the latter is exceeded at one operating speed of the propeller, it is exceeded at all other speeds thereof.

The pitch of the propeller blades may be manually varied against either the torque differential or the action of the centrifugal unit by manipulation of the operating lever 43. When the effect of the torque differential exceeds that of the centrifugal actuating unit it is merely necessary to release the detent 45, shown in Fig. 5, so as to allow the blades to turn to a position of reduced pitch under the force of the torque differential. The pitch of the blades may be increased under these conditions by rotating the operating lever 43 in a clockwise direction so as to shift the collar 35 and the bars 23 to the left, as viewed in Figure 1, thereby moving the plate 27 to the left.

When the pitch reducing turning effect of the torque differential is exceeded by that of the centrifugal actuating unit, releasing of the detent 45 on the operating lever 43 permits the blades to rotate to a position of increased pitch by the centrifugal unit. In this instance, the pitch of the blades may be decreased by rotating the operating lever 43 in a counter clockwise direction as viewed in Figure 5. When the centrifugal actuating unit is conditioned to substantially equalize the pitch reducing turning effect of the torque differential acting on the blades, it is necessary to manually rotate the operating lever 43 in respectively opposite directions in order to increase and decrease the pitch of the blades.

Regardless of the relative effectiveness of the centrifugal unit and the pitch reducing turning action of the torque differential, the manually operable control mechanism may be relied upon to selectively limit increasing of the pitch of the blades above a predetermined value.

In Figure 6 is illustrated a modified structure for rotatably supporting a propeller blade in a hub. In this form, the propeller blade 48 has a radial flange 49 on the extremity of its root end portion in which a groove 50 is formed. The edge portion 51 of the flange 49 is beveled and received upon a beveled seat 52 which extends inwardly of the hub portion 53. The hub portion 53 includes semi-cylindrical sections which are bolted or otherwise suitably secured together after assembly on the blades. Formed at the outer extremity of the hub portion 53 is an inwardly extending flange 54 in which is a groove 55 that registers with the groove 50 of the flange of the propeller.

A series of ball bearings 56 which are held in spaced relation by a ball retaining member 57 is located in the registering grooves 50 and 55 for rotatably supporting the propeller blade. The flange 54 holds the blade 48 against outward movement and the seat 52 prevents the blade from moving inwardly with respect to the hub, the seat 52 being spaced sufficiently from the flange 54 to afford slight clearance between the beveled edge 51 on the blade and the beveled seat 52 on the hub when the blade is urged outwardly by centrifugal force during rotation of the propeller. The ball retaining member is preferably split so as to enable mounting thereof on the root end portion during assembling of the propeller. When the ball bearings and their retainer are so mounted, the above clearance space allows assembling of the hub half-sections from respectively opposite direction, thereby bringing the flange of the blade and the bearings into the space between the flange 54 of the hub and the beveled seat 51 thereof. The steel of which the propeller and hub are formed is preferably nitrided, or otherwise hardened, and therefore the flanges 49 and 54 thereof serve successfully as ball races.

In the form of my invention, shown in Figs. 12 to 17 inclusive, the general construction of the propeller blades 8 hub 1, bearings which support the blades and manual operating apparatus, is substantially identical to that of the corresponding structure shown in Figs. 1 to 5 inclusive, and the parts of the structure are accordingly designated by numerals which correspond with the numerals of identical parts of the structure heretofore described in detail.

Located between the sleeves or bearings 16 in which the propeller shaft 17 is received is a collar 58 on which posts 59 are integrally formed. The posts 59 extend radially with respect to the axis of the shaft 17 and project into the interior of the propeller blades 8 and they are provided with threads 60 having a radial pitch. Threaded on the upper and lower posts 59 as viewed in Figure 12, are nut members 61 and 62, respectively, which have laterally extending lugs 63 and 64 respectively. Rigidly secured to the extremities of the lugs 63 and 64 are rectangular shaped bars 65 and 66, respectively, which are slidably received in slots 67 and 68 of cleats 69 and 70 that are secured by bolts 71 to the flanges 9 of the upper and lower blades 8 respectively as viewed in Figure 12. When the propeller is rotated the force of the centrifugal action to which the nuts 61 and 62 are subjected, urges the latter outwardly

causing them to rotate in respectively opposite directions. The lugs 63 and 64 through the medium of the bars 65 and 66, respectively, tend to turn the blades to positions of increased pitch against the action of the torque differential of the centrifugal action and wind pressure on the blades. By predetermining the weight of the nuts 61 and 62 the centrifugal actuating mechanism can be conditioned to either equalize or overpower the pitch reducing turning effect of the torque differential acting on the blade during rotation of the propeller, or the mechanism may be conditioned so as to allow the torque differential to predominate.

Slidably mounted on the left hand sleeve 16 of the hub in which the propeller shaft 17 is received is a ring 72 which is rigidly attached to the flanges 24 of the bars 23 that are slidably mounted in the grooves 22 of the right sleeve 16 of the hub and in registering grooves 73 in the collar 58. The ring 72 is provided with misaligned pins 74 and 75 which extend outwardly in opposite directions from respectively opposite sides thereof. The pin 74 is received in an elongated slot 76 formed in the lug 63 of the upper nut member 61 and the pin 75 is received in an elongated slot 77 in the lug 64 of the lower nut member 62. When the ring 72 is moved to the left by the manual control apparatus in the same manner as the plate 27 of the form shown in Figs. 1 to 5, the upper nut 61 is rotated in a clockwise direction and the lower nut 62 is rotated in a counter clockwise direction, as viewed from above Fig. 12, by the pins 75 and 74 respectively, which exert cam actions upon the sides of the slots in which they are received. Likewise, movement of the ring 72 to the right cams the upper nut member 61 in a counter clockwise direction and the lower nut member 62 in a clockwise direction.

The bars 65 and 66 which are carried by the lugs of the nuts turn the upper and lower propeller blades in respectively opposite directions so as to simultaneously increase their pitch when the ring 72 is either forcefully moved to the left by manual operation of the lever 43, shown in Fig. 5, or allowed to move to the left under the centrifugal action on the nut members when the detent 45 on the operating member 43 is released. Whether or not manual force is required to increase the pitch of the blades depends upon the relation of the intensity of the force differential created by wind pressure and centrifugal moments and the intensity of the turning effect of the centrifugal apparatus, as predetermined by the construction of the latter.

Although but several embodiments of this invention have been herein shown and described, it will be understood that numerous details of the constructions shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

I claim:

1. A propeller including a hub, a propeller blade rotatably mounted on said hub, said blade being urged in one direction about its axis of rotation by the force differential of the aerodynamic and centrifugal moments acting thereon during operation of said propeller, centrifugal apparatus for urging said blade about its axis in the other direction with a force having a lower magnitude than said force differential at substantially all operating speeds of said propeller, and actuating apparatus for positively turning said blade against the action of said force differential including means for releasably holding said blade

against displacement by said centrifugal apparatus.

2. A propeller including a hub, a blade rotatably mounted on said hub, a support in said hub, a guide on said support, a cylindrical inertia element rotatably and shiftably mounted thereon and adapted to move outwardly during rotation of said propeller, a member having an inclined plane contacting with the periphery of said inertia member and articulated with said blade for rotating the latter in one direction with respect to said hub, manually operable positive acting mechanism connected with said member for positively turning the said blade in the other direction against the action of said inertia elements, and means for releasably holding said mechanism in an adjusted position so as to positively secure said blade against turning relative to said hub.

3. A propeller including a hub, a blade rotatably mounted on said hub, a support in said hub, a threaded post on said support extending radially from said hub, a nut threaded on said post adapted to screw outwardly under centrifugal action during rotation of said propeller, means on said nut contacting with said blade for rotating the latter relative to said hub during outward movement of said nut, a shiftable member mounted on said support and connected with said nut, and manual actuating mechanism having a slip ring journaled on said shiftable member for rotating and holding said nut and said blade against said centrifugal action to predetermine the pitch of the latter.

4. A propeller including a hub portion having a socket therein, a blade extending into said socket and rotatable relative thereto, opposed concentric radially extending means on the walls of said socket and the inner end of said blade respectively for opposing outward movement of said blade including members having registering grooves of partial circular cross-section in the adjacent sides thereof, there being a clearance between the grooved member on said blade and the inner peripheral wall of said socket, and a single series of ball-bearing elements having substantially the same radius of curvature as and confined in the registering grooves of said members and independently sustaining the lateral and outwardly directed axial thrusts of said blade upon said hub portion.

5. A propeller including a hub portion having a socket therein, a blade extending into said socket and rotatable relative thereto, opposed concentric radially extending means on the walls of said socket and the inner end of said blade respectively for opposing outward movement of said blade, including members having registering grooves of partial circular cross-section in the adjacent sides thereof, there being clearance spaces between the grooved member of said blade and the inner periphery of said socket, and between the grooved member of said socket, and the outer periphery of said blade respectively, a single series of rolling contact elements confined in said registering grooves having substantially the same radius of curvature as the latter and independently sustaining the lateral and outwardly directed axial thrusts of said blade upon said hub portion, and means extending inwardly from the walls of said socket normally spaced from the inner side face of the grooved member of said blade during operation of said propeller for preventing inward movement of said blade when said propeller is inoperative.

6. A propeller including a hub portion having a socket therein, a blade rotatably mounted in said socket, opposed members on the walls of said socket and blade respectively, and a single anti-friction bearing unit surrounding said blade and extending between said members having a single series of rolling contact elements confined against movement radially of said hub portion and independently sustaining the lateral and outwardly directed axial thrusts of said blade upon said hub portion.

7. A propeller blade including a hub, a blade rotatably mounted on said hub, centrifugal means for urging said blade toward an increased pitch position including a shiftable member connected with said blades and a shiftable and rotatable inertia member having rolling contact therewith and constituting the major portion of the speed responsive mass of said centrifugal means, said means being so constructed and arranged as to overcome all pitch reducing forces normally acting on said blade during all operating speeds of said propeller, manually operable mechanism adapted to overcome the pitch increasing influence of said means at any operating speed of said propeller for positively decreasing the pitch of said blade, and releasable means for positively holding said manual actuating mechanism in a selected position so as to retain said blade in a predetermined pitch position against the action of said actuating means.

8. A propeller blade including a hub, a blade rotatably mounted on said hub, said blade being normally urged toward a reduced pitch position by forces derived by operation of said propeller, centrifugal means for urging said blade toward an increased position including a speed responsive member consisting solely of a rotatable inertia element shiftable radially of the axis of said propeller and articulated with said blade, said means being so constructed and arranged as to apply counter turning forces on said blade of different magnitude than said first mentioned forces at all operating speeds of said propeller, and control mechanism including manual operating means for positively turning said blade against the differential of said forces and including means for holding said blade and operating mechanism in a selected position.

9. A propeller including a hub structure, an adjustable blade rotatably mounted thereon, a support in said hub structure, a member shiftable mounted in said hub structure and articulated with said blade for varying the pitch thereof, and means for actuating said shiftable member including a speed responsive mass consisting of a rotatable and shiftable inertia element having rolling contact with said member and rotatably and shiftably mounted on said support, said inertia member being responsive to rotation of said propeller.

10. In a propeller including a hub and having a blade rotatably mounted thereon; centrifugal means for urging said blade in one direction about its axis to vary its pitch including a member shiftable mounted on said propeller and articulated with said blade, and speed responsive means for actuating said member including a roller shiftable and rotatably mounted on said propeller having rolling contact engagement with said member and constituting the major portion of the weight of said speed responsive means.

JOHN SQUIRES.

CERTIFICATE OF CORRECTION**Patent No. 2,008,191.****July 16, 1935.****JOHN SQUIRES.**

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 43, for "Fig. 9" read Fig. 10; and line 55, before "ball" insert the words series of; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of August, A. D. 1935.

Leslie Frazer**(Seal)****Acting Commissioner of Patents.**