July 18, 1961 D. BIERMANN 2,992,688

ADJUSTABLE PITCH PROPELLER

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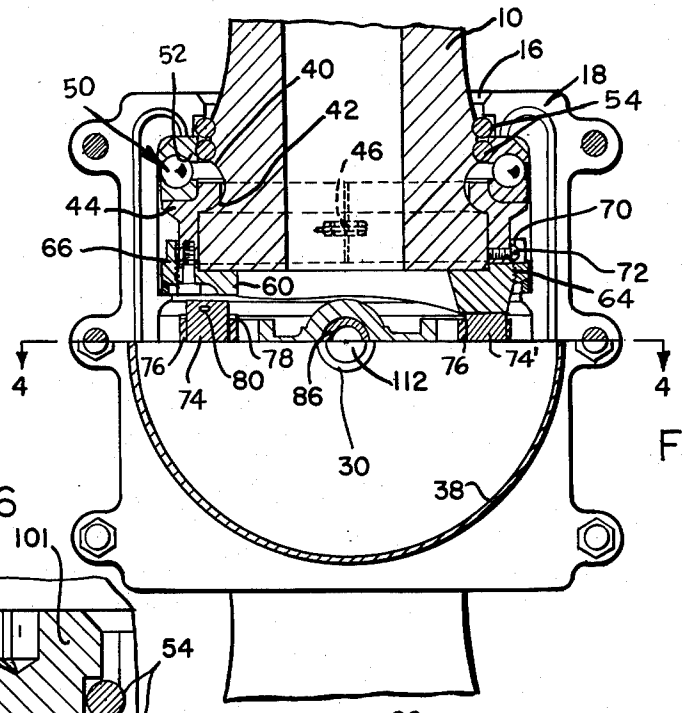


FIG-3

FIG-6

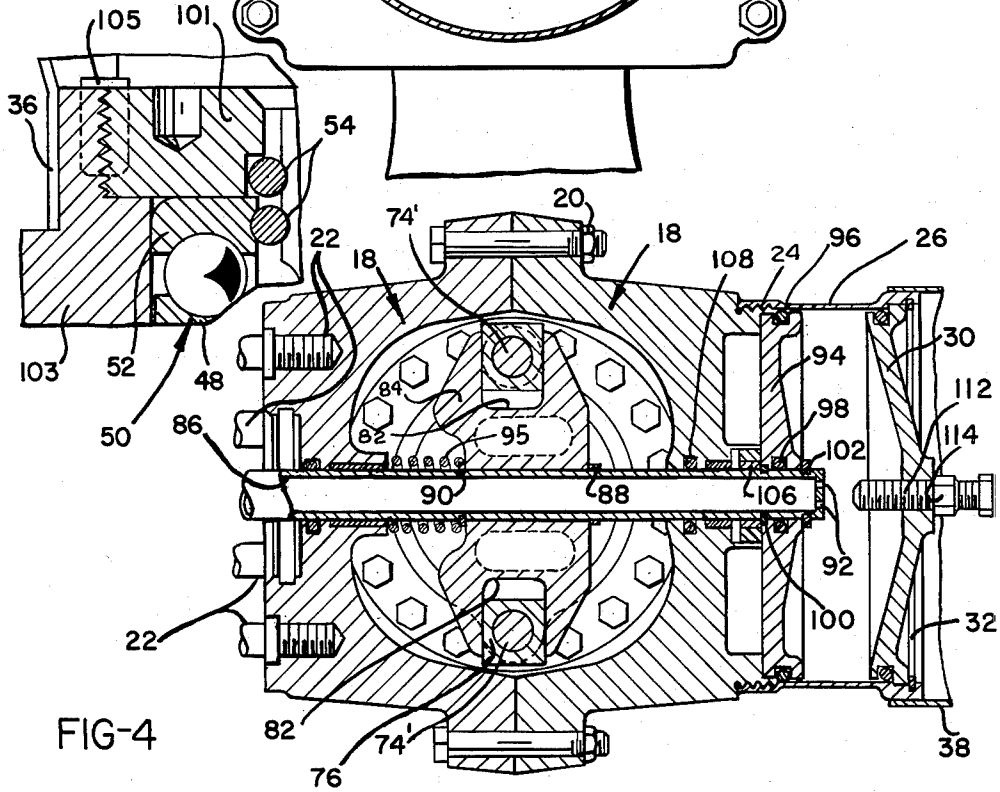


FIG-4

INVENTOR.
DAVID BIERMANN

BY Toulmin & Toulmin

ATTORNEYS

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FIG-1

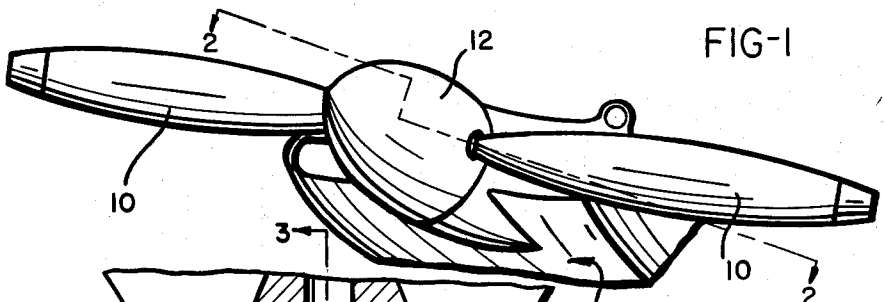


FIG-2

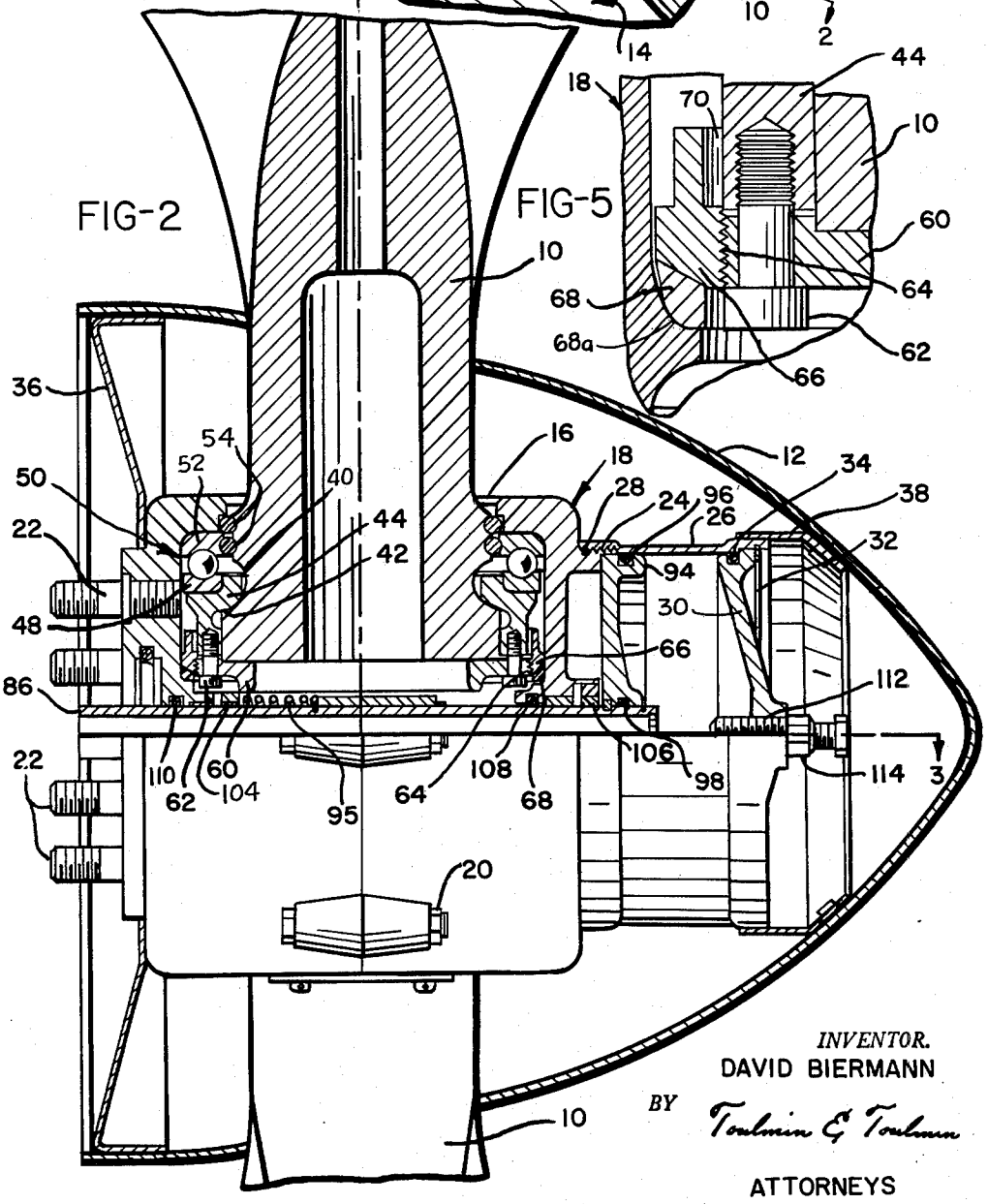


FIG-5

INVENTOR.
DAVID BIERMANN

BY Toulmin & Toulmin

ATTORNEYS

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ADJUSTABLE PITCH PROPELLER

David Biermann, Piqua, Ohio, assignor to Hartzell Propeller, Inc., Piqua, Ohio, a corporation of Ohio

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7 Claims. (Cl. 170—160.32)

This invention relates to propellers, and particularly to adjustable pitch propellers, and more particularly still to arrangements for supporting the movable propeller blades in the hub therefor.

The usual type adjustable pitch propeller has an arrangement with two or more blades projecting radially therefrom, and with these blades being supported on antifriction bearing means within the hub so as to be rotatable therein for varying the pitch of the propeller. The support of such propeller blades must be firm and strong but relatively friction-free, thereby to permit ready adjustment of the blades about their axes while at the same time holding the blades in the hub against the strong centrifugal forces acting outwardly thereon as the propeller rotates.

The present invention has for its particular object the provision of an improved arrangement for clamping the propeller blades in the hub that supports the blades of the propeller.

A still further object of this invention is the provision of an arrangement for pre-loading the bearing which supports the propeller blade thereby preventing any axial movement of the propeller blade as the speed of rotation of the propeller changes.

A still further object is the provision of an arrangement for rotatably mounting a propeller blade in its supporting hub which permits rapid assembly of the propeller blades and the hub, and in which arrangement the respective parts are relatively simple to machine during the manufacturing of the propeller unit.

A still further object of this invention is the provision of a propeller blade supporting structure in which the parts interfit closely and support and align each other in the blade socket.

These and other objects and advantages of this invention will become more apparent upon reference to the following specification taken in connection with the accompanying drawings, wherein:

FIGURE 1 is a perspective view showing a typical propeller installation;

FIGURE 2 is a section indicated by line 2—2 on FIGURE 1 showing the internal construction of the propeller arrangement;

FIGURE 3 is a vertical section indicated by line 3—3 on FIGURE 2;

FIGURE 4 is a plan sectional view indicated by line 4—4 on FIGURE 3;

FIGURE 5 is a fragmentary view drawn at somewhat enlarged scale showing the manner in which the pre-load nut threads on the outer periphery of the blade crank ring and engages the pre-load ring within the blade hub; and

FIGURE 6 is a fragmentary sectional view showing the manner in which the internal abutment about the mouth of the blade socket can be provided by threading a ring into the said mouth.

Referring to the drawings somewhat more in detail, the propeller of FIGURE 1 comprises the blades 10 mounted in a hub located within spinner 12 and attached to the drive shaft of an engine positioned within the nose 14 of an aircraft.

As will be seen in FIGURE 2, the blades 10 have their inner butt ends located in the blade sockets 16 in a hub 18 comprising front and back halves that are formed with integral lugs to receive the clamping bolts 20.

The back half of the hub has associated therewith the

studs 22 by means of which the hub is attached to the flange of an engine shaft for driving the propeller in rotation. The opposite end of the hub is provided with a threaded extension 24 that receives the end of a cylinder 26 which is sealed to the hub as by O ring 28, while at its outer end there is mounted within a shouldered recess in the end of the cylinder the closure member 30. This closure member is retained in position by a snap ring 32 and sealed to the wall of the cylinder 26 by O ring 34.

The left side or rear half of the hub also supports the disc-like element 36 which is flanged about its periphery to form a support for the base end of spinner 12. The outer end of spinner 12 may have a cylindrical element 38 attached to the inside thereof that telescopically engages the outer end of cylinder 26 to provide further support for the spinner. According to the present invention, the inner or butt end of each blade 10 is formed with an annular recess 40 that provides a shoulder 42 at the inner end of the propeller for engagement by blade collar 44. Blade collar 44 is split, being formed in halves and may be connected together as by cap screws 46.

It will be evident that blade collar 44 engages the cylindrical portion of the extreme inner butt end of the blade and also engages the shoulder formed on the outer side of the flange at the inner end of the blade. Blade collar 44 also engages the innermost surface of the inner race 48 of ball bearing 50 and closely fits within the internal diameter of the inner race so as to be located and supported thereby. The race 52 of the bearing thus serves as a hoop to hold the blade collar in place against separating forces exerted thereon by the blade when the propeller is rotating. Bearing 50 also has an outer race 52 having its outer face and external diameter engaging machined surfaces within the mouth of the blade socket pertaining to blade 10. It will be evident that the ball bearing and blade collar structure provide means for accurately rotatively supporting the blade within the blade socket.

The blade socket may be sealed by the positioning of the O rings 54 between the blade and the mouth of the blade socket, and also between the blade and the stationary race 52 of ball bearing 50.

According to the present invention, the blade collar 44 is locked fixedly in place on the butt end of the pertaining blade by a blade ring means 60 which has a shallow recess receiving the extreme inner butt end of the blade, and which is attached to the blade collar by a plurality of cap screws 62 whereby to provide an extremely rigid connection between the blade collar and the blade crank, and to fixedly and tightly clamp the blade therebetween.

The outer periphery of the blade ring means 60 is threaded as at 64, and receives a blade pre-load nut 66 which has its lower edge tapering upwardly and outwardly in order to engage a pre-load ring 68 that engages an abutment 68*a* in the form of a mating surface in the blade socket as can be seen in FIGURE 5. This pre-load ring is advantageously formed of a plastic material or of any other material which will provide a suitable bearing for the pre-load nut without binding against the said nut, thus constituting a friction reducing element between nut 66 and the abutment in the bottom of the blade socket.

The said pre-load nut 66 has an axially extending flange portion provided with slots 70, as will be seen in FIGURE 5; and these slots 70 can be availed of for receiving a locking pin or screw 72 to fix the pre-load nut in position after it has been adjusted to the proper place.

As will be seen in FIGURES 3 and 4, each blade is provided with a crank pin 74 and 74', and these pins are located on opposite sides of the longitudinal center line of the propeller assembly. Each pin 74 and 74' extends into a block 76 which may be of a resinous material if so

desired, although any bearing material will be satisfactory.

A plastic material is preferred because it has adequate strength and is light in weight. Each block 76 is held in place on its pertaining crank pin by a washer 78 and cotter key 80. Each of the said blocks is located in a slot 82 in a pitch changing fork 84 located on a tube 86 extending along the axis of the hub. Tube 86 has a ring fixed thereto at 88, and is adapted for receiving a snap ring 90 by means of which the pitch changing fork is fixed in position on the said tube. It will be evident, particularly upon reference to FIGURE 4, that axial movements of the tube 86 will be accompanied by rotating movement of the propeller blades on their axes whereby the pitch of the propeller can be adjusted.

Axial movements of the said tube are obtained by a reversible supply of pressure fluid to the cylinder 26. The supply of fluid to the cylinder 26 is accomplished by passing oil under pressure along tube 86 and out the apertures 92 in the extreme outer end thereof, to the space on the outer side of piston 94, and this will thrust the piston inwardly of the cylinder 26. A spring 95 and the centrifugal twisting moment acting on blades opposes the action of the pressure fluid. Exhausting of fluid from the cylinder through tube 86 will permit piston 94 to move outwardly. A control system for the fluid of a conventional type may be employed wherein speed responsive and pilot operated control elements determine the pitch of the propeller by a reversible supply of fluid under pressure to tube 86.

Piston 94 sealingly engages cylinder 26 as by the peripheral O ring 96, and sealingly engages the tube 86 as by the internal O ring 98. Axial movement of the piston on the tube is prevented by the provision of the split collar 100 on one side of the piston and the snap ring 102 on the other side of the piston.

The piston is thus fixed to tube 86 and sealed to both the tube and the cylinder.

The tube 86 is slidably supported in the hub 18 by the bushings 104 and 106 in the hub, and is sealed against leakage of oil by the O rings 108 and 110.

In the arrangement illustrated, the inward movement of the piston 94 moves the propeller blades toward increased pitch position, and outward movement thereof moves the propeller blades toward decreased pitch position. The provision of counterweights on the blades in the proper position, however, would permit the function of the piston to be reversed so that a supply of pressure to the piston will decrease propeller pitch. The minimum pitch position of the propeller blades can be determined by the adjustable stop screws 112 threaded through the cylinder closure 30 and provided with a clamp nut 114.

In FIGURE 6 it will be observed that the internal abutment about the mouth of the blade socket is provided by threading a ring 101 into the hub 103 thereby abutting the outer surface of the outer race 52 of the thrust bearing. The ring 101 can be locked in place by a lock screw 105 if desired.

This arrangement has the merit of somewhat simplifying the machining of the hub and also permits the propeller blade and the decribed interfitting support arrangement therefor to be placed in or removed from the hub without separating the two halves of the hub.

In any case, it will be noted that the outer race of the bearing is located on its outer diameter and outer face in the hub while the blade collar is held together by the inner race of the bearing and located by the inner face and inner diameter thereof. The blade is clamped to the blade collar by the blade crank and is thus supported in the hub against all centrifugal and bending loads imposed thereon.

I claim:

1. In a variable pitch propeller blade structure, a hub, said hub consisting of two halves with a parting line in the plane of rotation of the propeller blades, bolt means for holding said two halves of the hub together, blade sockets in said hub, an inwardly extending peripheral flange means in the mouth of each socket forming abutment means facing the bottom of the socket, an antifriction bearing having unbroken one-piece races and bearing elements therebetween mounted in said socket so that one race thereof engages the periphery of the socket and the underside of the abutment means, a propeller blade disposed in each socket and extending through said bearing, an outwardly extending flange on the butt end of said blade smaller than the inside diameter of said bearing, a split collar mating with both the upper face and outer periphery of said flange and the inner face of another race of said anti-friction bearing, said collar terminating short of the inner end of said blade, blade ring means engaging the butt end of said blade and bolted to said collar for clamping of said collar in place, and means extending axially of and carried by said ring means for rotation of the blade about its axis to vary the pitch.

2. In a variable pitch propeller blade structure, a propeller hub, said hub comprising mating halves separable in the plane of rotation of the propeller blades, blade sockets formed in said hub and each socket having an inwardly extending peripheral abutment about the mouth thereof, an anti-friction bearing having unbroken one-piece races and bearing elements therebetween closely fitted in the socket having one race engaging said abutment, a propeller blade extending into each socket and through said bearing, means comprising an outwardly extending flange adjacent the butt end of each blade, a split collar fitted about the butt end of the propeller engaging the outer face and periphery of said flange, said split collar terminating short of the extreme inner end of said blade, said collar having means mating with both the inner face and inner diameter of another race of said anti-friction bearing whereby the said anti-friction bearing acts as a hoop holding the split collar in place on the blade, and a blade ring engaging the butt end of the blade and connected with said collar by a plurality of cap screws to hold the collar in place and fixedly clamp said blade ring and split collar together.

3. In a variable pitch propeller; a blade retention comprising a hub, a plurality of blade receiving sockets dispersed in said hub, an inwardly extending circumferential abutment in the mouth of each socket, a first unbroken one-piece bearing race engaging the inner face of said circumferential abutment and closely fitting the inside of said socket, a blade extending into said socket and through said first bearing race, an outwardly extending flange integral with said blade at the inner end thereof, a segmented collar surrounding and overlying the upper and outer surfaces of said blade flange and terminating short of the extreme inner end of said blade, said collar being formed with a flange extending outwardly with respect to the blade axis, a second unbroken one-piece bearing race mounted on said split collar and engaging said collar flange, a series of balls disposed between said first and second bearing races to form therewith an antifriction bearing, a ring plate engaging the extreme inner end of the said blade, means connecting the ring plate with said collar for drawing the collar downwardly against the flange on the blade and for clamping the said blade flange between said split collar and said ring plate, said outwardly extending flange on the inner end of the blade being smaller in diameter than the internal diameter of the races thereby to permit assembly of the antifriction bearing over the end of the blade prior to the placing of said split collar thereon.

4. A variable pitch propeller according to claim 3 in which said ring plate is threaded on the outer diameter thereof, an outwardly facing abutment surface in said socket located inwardly of the extreme inner end of the blade, and a threaded ring nut mounted on the threaded

outer periphery of said ring plate and engaging the said abutment surface within the socket.

5. A variable pitch propeller according to claim 4 in which said ring plate is formed with a journal element extending inwardly therefrom on an axis parallel with the blade axis but disposed laterally thereof, and link means attached to said journal for effecting adjustment of the pitch of the blade connected with the said ring plate.

6. A variable pitch propeller according to claim 5 which includes a cylinder mounted on the said hub coaxially with the axis of rotation thereof, a piston slidably mounted within said cylinder, a piston rod connected to said piston and extending axially through said hub on the rotational axis thereof, said piston rod being connected with said link means for rotation of the blade upon axial movement of said piston and piston rod.

7. A variable pitch propeller according to claim 5 which includes a cylinder mounted on the said hub coaxially with the axis of rotation thereof, a piston slidably mounted within said cylinder, a piston rod connected to said piston and extending axially through said hub on the rotational axis thereof, said piston rod being connected with said link means for rotation of the blade upon axial movement of said piston and piston rod, there being means for supplying oil under pressure through said piston rod to one side of said piston for causing movement of the piston and piston rod in said cylinder.

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