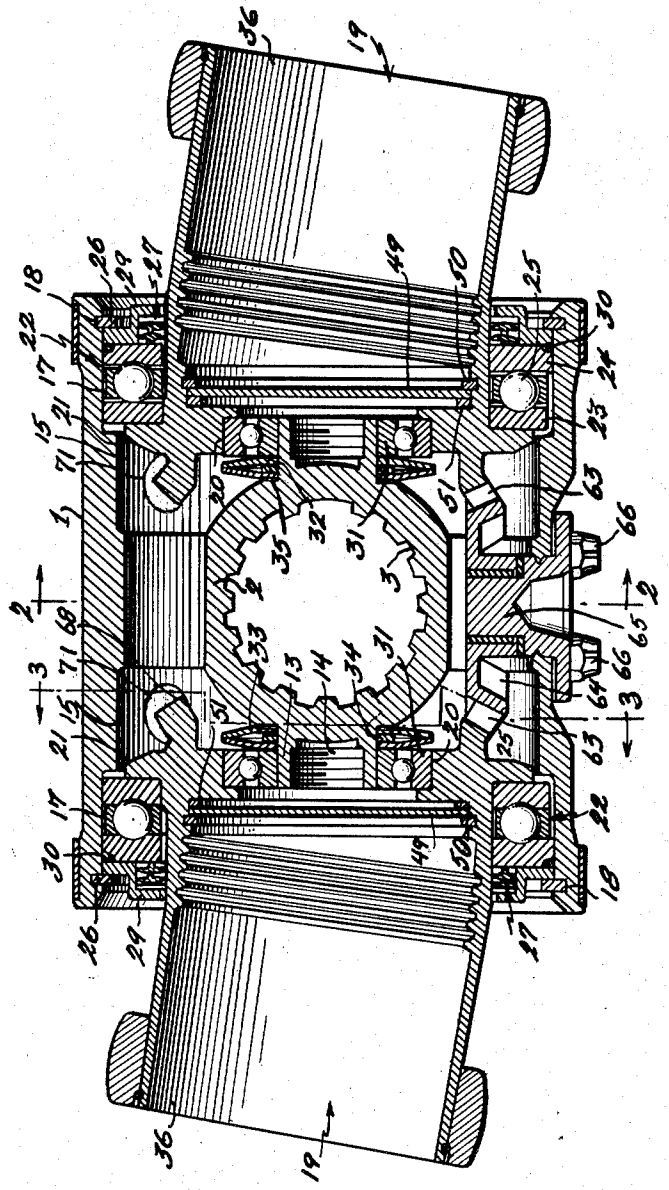
Sept. 4, 1951 P. F. HACKETHAL ET AL 2,566,884

PRELOADED PIVOT MOUNT FOR VARIABLE PITCH PROPELLER BLADES

Filed Nov. 24, 1948 3 Sheets-Sheet 1

FIG. 1.



Inventors
PAUL F. HACKETHAL
ROMUALD KAREY

By

Semmes, Keegin, Robinson & Semmes
ATTORNEYS

Sept. 4, 1951 P. F. HACKETHAL ET AL 2,566,884

PRELOADED PIVOT MOUNT FOR VARIABLE PITCH PROPELLER BLADES

Filed Nov. 24, 1948 3 Sheets-Sheet 2

FIG. 2.

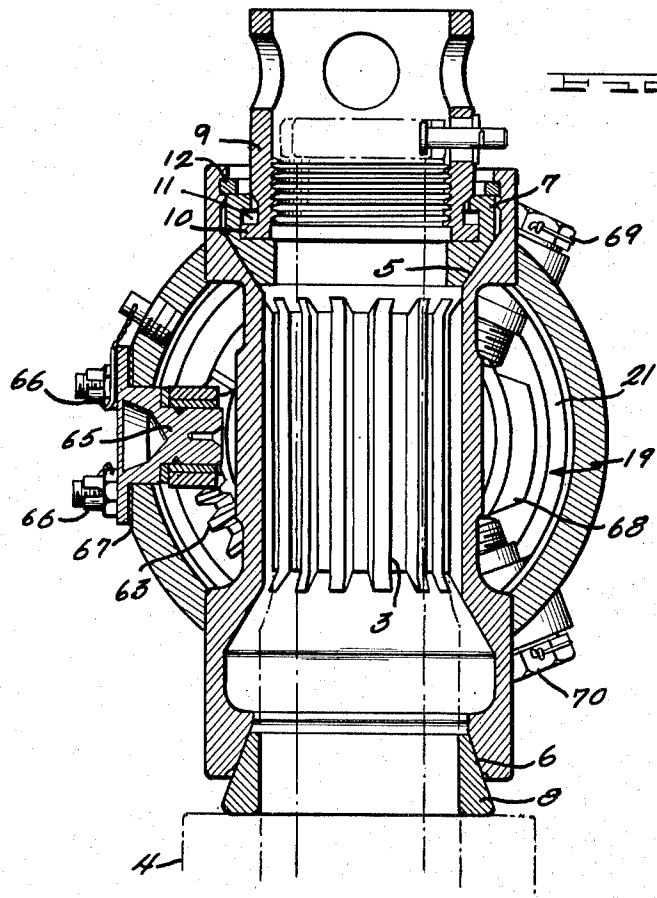
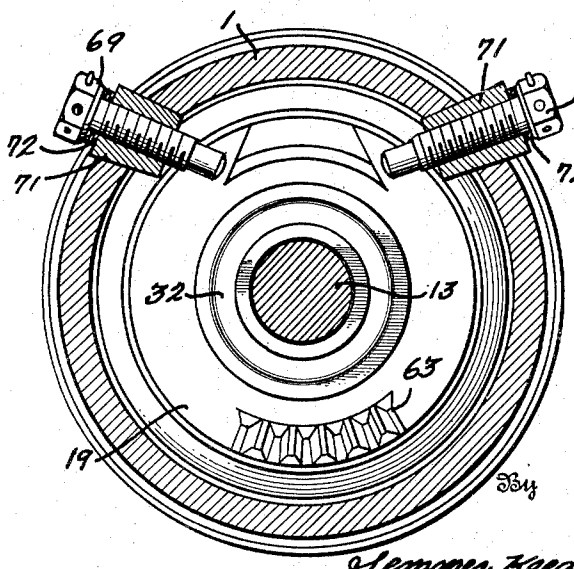


FIG. 3.



Inventors
PAUL F HACKETHAL
ROMUALO KAREY

By

Semmes Keegin, Robinson & Semmes
ATTORNEYS

Sept. 4, 1951 P. F. HACKETHAL ET AL 2,566,884

PRELOADED PIVOT MOUNT FOR VARIABLE PITCH PROPELLER BLADES

Filed Nov. 24, 1948 3 Sheets-Sheet 3

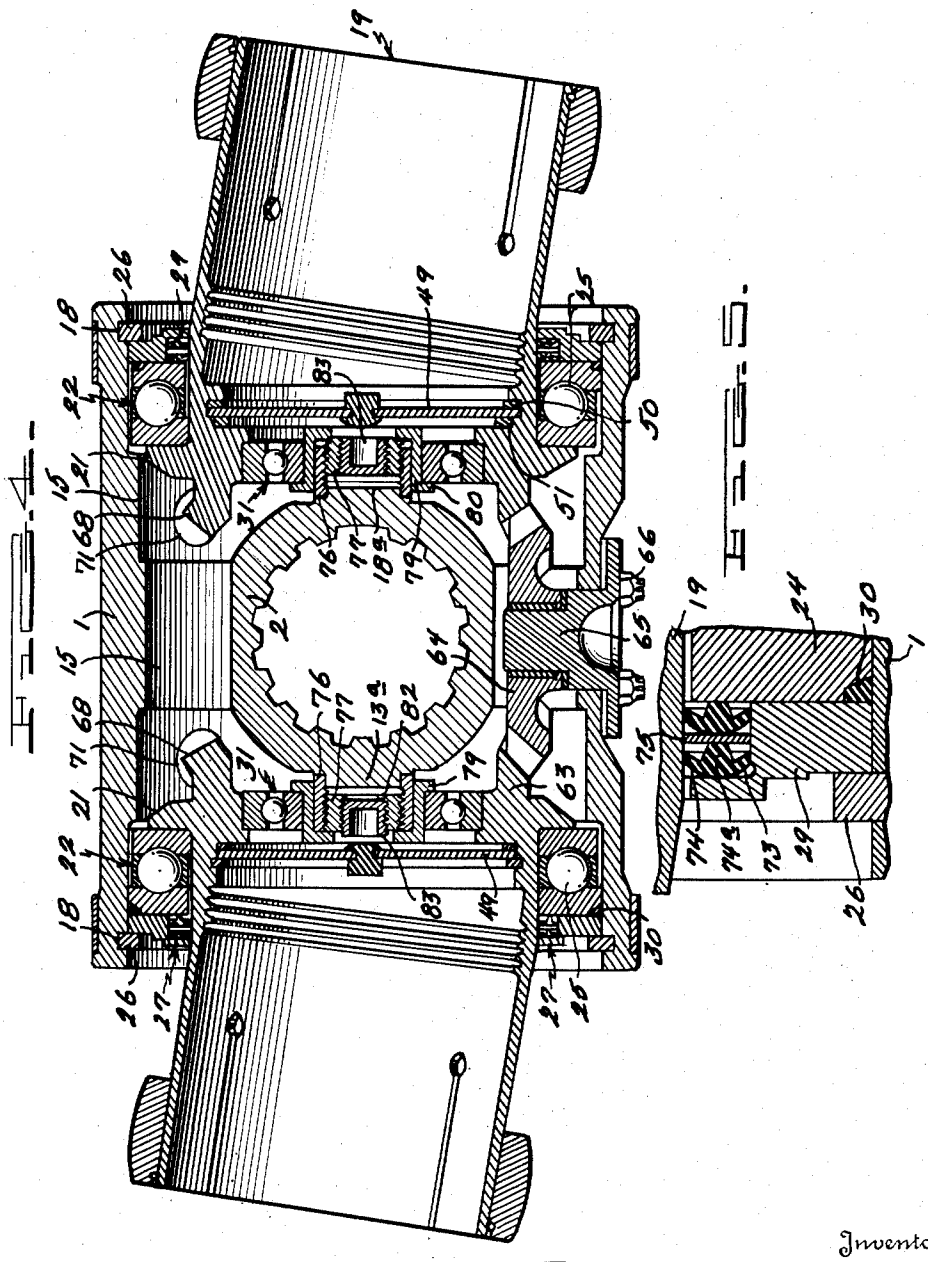


FIG. 4.

FIG. 5.

Inventors
PAUL F. HACKETHAL
ROMUALD KAREY

By

Semmes, Keegin, Johnson & Semmes,
ATTORNEYS

Patented Sept. 4, 1951 2,566,884

UNITED STATES PATENT OFFICE

2,566,884

PRELOADED PIVOT MOUNT FOR VARIABLE PITCH PROPELLER BLADES

Paul F. Hackethal, Wentworth, N. H., and Romuald Karey, Cockeysville, Md., assignors to Everel Propeller Corporation, Baltimore, Md., a corporation of Maryland

Original application May 7, 1945, Serial No. 592,496. Divided and this application November 24, 1948, Serial No. 61,794

6 Claims. (Cl. 160—23)

1

This invention relates to propellers for aircraft, and is a division of our copending application Serial No. 592,496, filed May 7, 1945 (now abandoned), which is a continuation-in-part of that described in our copending application Serial No. 508,352, filed October 30, 1943; which matured into Patent No. 2,528,236 on October 31, 1950.

More particularly the present invention relates to improved means for rotatably mounting the propeller blades in a hub for pitch changing movement therein with particular reference to axially expansible means interposing between the transverse shaft coupling tube of the hub and a rotary flanged sleeve which pivotally mounts the blade in the hub to preload the antifriction bearings for the sleeve. The invention is additionally directed to sealing means to inhibit leakage of lubricant from the hub.

An automatic pitch changing propeller has been developed in which the shanks of the blades are secured in flanged sleeves, these in turn being mounted for rotation in the hub. The construction of the blade sleeves is such that the longitudinal axes of the blades are at an angle to the rotational axes of the sleeves with the result that, in flight, the rotational position of the blades with respect to the hub, and as a consequence, the pitch angle of the blades is affected by various conditions encountered in flight, principally the relationship of the following forces reacting on the blades: aerodynamic force due to thrust reacting on the blades in a direction normal to the plane of rotation of the propeller, which tends to rotate the angularly disposed blades about the arc of a cone in a forwardly direction to decrease their pitch; centrifugal force reacting on the blades to move them into the plane of rotation and which may be pitch increasing or pitch decreasing movement, depending respectively upon whether the blades are in the forward or rear quadrant with respect to the plane of rotation; and the centrifugal force due to counter weights secured to the blades which tend to bring all forces into equilibrium.

While a high degree of perfection has been obtained in such propellers, both in construction and operation, certain difficulties have been encountered, particularly in assembly and adjustment and in correctly and accurately preloading the blade bearings.

An important object of the invention is to provide an improved means for preloading the blade bearings in automatic variable pitch propellers.

Another object of the invention is to provide

2

approved means for preloading the blade bearings in an automatic variable pitch propeller which are easily and accurately adjustable to within fine limits to a predetermined load after assembly of the hub, and incorporating means for positively locking the preloading means in adjusted position.

A still further object is to provide means for accurately and easily adjusting propellers of the above character for desired limits of pitch change movement of the blades.

Yet another object of the invention is the provision of an improved oil seal for such propellers and an improved means for installing the same.

With these and other important objects in view which may be incident to our improvements, the invention consists in the parts and combinations to be hereinafter more fully set forth and claimed, with the understanding that various changes may be made therein by those skilled in the art without departing from the spirit of the invention or exceeding the scope of the appended claims.

In order to make the invention more clearly understood, reference is made to the accompanying drawings which are employed to illustrate means for carrying the invention into practical effect without limiting the same to the particular constructions shown by way of illustration:

In the drawings:

Figure 1 is a transverse sectional view of a propeller hub according to the invention;

Figure 2 is a cross sectional view taken substantially along the lines 2—2 of Figure 1 looking in the direction of the arrows;

Figure 3 is a cross sectional view taken substantially along the line 3—3 of Figure 1 looking in the direction of the arrows;

Figure 4 is a transverse sectional view of a modified form of hub construction according to the invention, and

Figure 5 is an enlarged fragmental view in cross section of the oil seal shown in Figure 4.

While the improvements constituting this invention are shown and described as applied to a two blade, automatic variable pitch propeller, the invention is not to be construed as being so limited as it is obvious that the improvements are equally applicable to propellers having a single or more blades and that certain of the improvements, particularly with reference to blade and propeller balancing, are applicable to other types of detachable blade propellers and rotors.

Referring now to the drawings, the two blade propeller hub, as will be best seen in Figures 2 and 3, comprises a cylindrical barrel portion 1 and a transverse shaft coupling element 2. The shaft coupling element 2 may be either integrally formed with the barrel portion 1, or, preferably, machined as a separate sleeve and inserted transversely through the barrel 1 and secured to opposite walls thereof by suitable means such as welding, as illustrated in Figure 2. The shaft coupling element 2 is integrally machined to provide a splined bore 3 to fit a correspondingly splined end of a propeller shaft 4.

Opposite ends of the shaft bore 3 are taper bored to provide a front cone seat 5 and a rear cone seat 6 adapted to seat respectively the usual front and rear hub centering cones 7 and 8 which are drawn toward each other, to center and secure the hub on the propeller shaft, by a hollow nut 9 screw threaded on the end of the propeller shaft 4. It is to be noted that the nut 9 is provided at its inner end with an external flange 10 which cooperates with an internal groove 11 in the front cone 7 to force the front cone toward the rear cone when the nut is drawn up, and to pull the front cone forwardly when the nut 9 is backed off. As an additional means to prevent accidental longitudinal displacement of the front cone 7 a snap ring 12 is provided in the forward end of the bore of the blade coupling element. Formed on, or secured to, opposite sides of the blade coupling element 2 is a cylindrical boss 13 axially aligned with the longitudinal axis of the blade barrel 1. Each of these bosses is provided with a cylindrical screw threaded socket 14.

As seen in Figure 1, the blade barrel 1 has a longitudinal bore at each end to provide blade receiving sockets 15 for mounting opposed propeller blades, not shown. Each of these sockets is somewhat enlarged, as indicated at 17, to receive a thrust bearing structure to be described later, and is provided with an internal groove 18 adjacent the end of the barrel.

Positioned in each end of the barrel 2 is a blade mounting sleeve 19 centrally bored adjacent its inner end to provide an internally flanged bearing socket 20. Also adjacent the inner end of each sleeve 19 is an external peripheral flange 21.

Positioned about each of the sleeves 19 is an annular thrust bearing element designated generally as 22 and consisting of parallel ball races 23 and 24 between which are positioned bearing balls 25. The inner ball race 23 engages the outer surface of the sleeve 19 and is seated against the external flange 21, while the outer race 24, which is free to rotate relative to the sleeve, engages the inner surface of the enlarged bore 17 of the blade barrel. Outward movement of the thrust bearing 22 is blocked by means of a snap ring 26 fitted into the groove 18. An oil seal, designated generally as 27 and which will be described in more detail later, is held within a retaining ring 29 positioned between the outer ball race 24 and snap ring 26 while an additional sealing ring 30 is provided between the ball race 24, the ring member 29, and the inner surface of the barrel 1. Sealing elements 27 and 30 effectively prohibit leakage of oil from the interior of the hub past the relatively movable parts.

In addition to the thrust bearing 22, a second journal is provided for additionally supporting the sleeve 19 within the hub barrel. This latter journal comprises a radial ball bearing 31, the outer race of which is seated within the internally flanged socket 20 of the blade sleeve, and the inner race carried by the cylindrical boss 13.

In order to load the bearings 22 and 31 to secure optimum operation thereof, a preloading device is incorporated in the hub structure. One embodiment of preloading device is shown in Figure 3 and consists of a pair of resilient cup shaped annular discs 32 and 33 which are positioned on the boss 13 between the bearing 31 and the shaft coupling sleeve 2. The discs 32 and 33 have their concave surfaces facing each other and their outer peripheral edges in engagement, the inner periphery of the outer disc 33 engaging the bearing 31 and the inner periphery of the inner disc 32 lying adjacent the shaft coupling sleeve 2. There is preferably positioned between the inner peripheries of the two discs a spacing ring 34 which serves to limit the amount of permissible compression; and there may be inserted between the disc 32 and the shaft coupling sleeve 2 a washer 35 of suitable thickness to insure the desired load upon the bearings. The washer 35 may be formed of laminated shim material whereby the desired thickness of the washer for any given assembly may be readily varied. In assembling the hub, the discs 32 and 33 together with the associated washer and spacing ring are placed on the boss 13 and the blade sleeve with its bearings 22 and 31 is inserted in the socket 15 of the hub. A suitable assembly tool, provided with a flange to engage the inner end of the blade sleeve, is screwed into the threaded socket of boss 13 to draw the blade sleeve inwardly and compress the discs 32 and 33. The snap ring 26 is then placed in groove 18 and the tool removed. The load by the discs 32 and 33 maintains the sleeve in assembled position.

Each of the sleeves 19 is provided with a bore 36 extending from the outer end thereof to adjacent the inner end at a predetermined and calculated angle to the axis of rotation of the sleeve in the hub. The angular bore 36 is for the reception of the shank of a propeller blade which is held against axial displacement therein by screw threaded engagement with internal threads 37 formed adjacent the inner end of the bore.

To prevent leakage of oil from the interior of the hub through the blade sleeves, the inner end of the sleeve bore is fitted with a closure disc 49, held therein by a snap ring 50 and sealed into oil-tight engagement with the sleeve by a gasket 51.

It is advantageous in automatic pitch change propellers that the pitch changing rotation of the blades be synchronized and to this end, each of the blade sleeves 19 is provided on its inner end with a bevel gear segment 63. These gear segments are operatively connected by a pinion-like member 64 pivotally mounted on a flanged stud member 65 which is inserted through an aperture in the wall of the blade barrel 1 and secured thereto by cap screws 66 passing through the stud flange and into the blade barrel. Preferably shim material 67 is interposed between the stud flange and the blade barrel to adjust position of the pinion 65 radially in the blade barrel, that is, toward the axis of rotation of the blade sleeves to eliminate back lash between the pinion and the mating gear segments 63.

To limit the rotational movement of the sleeves 19 and, as a consequence, to regulate the magnitude and the degree of pitch increasing and/or pitch decreasing movement of the blades, each sleeve is provided with a segmental abutment

member 68 on its inner end, diametrically opposite the gear segment 63. Each of these abutment members 68 moves in the path of a pair of stop screws 69 and 70 carried by the hub barrel 2 and adjustable toward and away from the abutment 68 from outside the hub barrel. Preferably the stop screws 69 and 70 are threaded through sleeves 71 which are of sufficient size and weight, together with the screws 69 and 70, to substantially counterbalance the pinion 64 and its supporting stud on the opposite side of the hub. Also there is preferably positioned between the heads of the screws 69 and 70 and the sleeves 71 washers 72 composed of laminated shim material for accurately adjusting the screws and maintaining their adjusted positions. Preferably the sleeves 71 are rigidly secured to the hub barrel as by brazing or welding, but alternately they may be screw threaded into the barrel for further adjustment of the stops.

Lubricant within the propeller hub is subjected to rather high centrifugal force in the operating propeller which tends to force it out past the blade sleeve. One type of oil sealing element which we have found very efficient in preventing leakage is a chevron type shown in the enlarged view, Figure 5. This is a ring 73 of neoprene or other suitable oil resistant material shaped in cross section substantially in the form of a V defining laterally extending wings 74 with a rib 74a in the angle of the V. Usually two or more of these rings are used in a seal and maintained under axial pressure, the rib serving, when under pressure, to expand the wings 74 laterally into close engagement with its cooperating surfaces of the hub structure, in this case the side wall of the retaining ring 29 and the outer periphery of the blade sleeve. Considerable difficulty has been encountered heretofore, however, when compressing a number of these rings, in maintaining them in axial alignment due to the tendency of the rib to overlap the angular face of the adjacent ring. To eliminate this defect, we interpose a thin annular disc 75 between adjacent rings to provide a substantial, flat surface normal to the direction of compression movement of the rib. In Figure 3, the disc 75 is omitted, but this is usually inadvisable.

A modified form of bearing preloading device which has been found highly effective in equally loading the blade bearings because of its high degree of close and accurate adjustment is illustrated in Figure 4. This preloading device consists of an internally screw threaded sleeve 76, and an externally screw threaded tubular element 77 threadedly engaging the sleeve 76 for telescoping movement with respect thereto. The sleeve 76 is rigidly secured to a short stud 13A, formed on the side of the shaft coupling sleeve 2 coaxially with the barrel 1. A ring 79 surrounds the sleeve 76 and is provided with an internal flange 78 which is seated upon the outer end of tubular element 77. The opposite end of the ring 79 has an external flange 80 which forms a seat for the inner race of the bearing 31.

The outer end of tubular element 77 is provided with slots (not shown) for engagement by a suitable tool to screw it into sleeve 76. The position of element 77 within sleeve 76 determines the position of ring 79 and consequently the degree of preloading. In order to maintain the adjustment of element 77 within the sleeve 76 against accidental displacement, the element 77 is slit longitudinally, as indicated at 81, and provided with a tapered axial bore 82 in which is screw threaded a tapered screw 83.

In assembling the hub shown in Figure 4, all bearing preload parts are moved inwardly by screwing the elements 77 into the sleeves 76. The blade sleeves 19 with their bearings and oil seals in place are inserted into the hub sockets, the inner race of the bearing 31 about the ring 79 and in engagement with the external flange 80. The blocking snap rings 26 are then inserted in their grooves 18 and the elements 77 backed out with respect to the sleeves 76 until the bearings are loaded as desired which may be ascertained by suitable torque measuring instruments. The tapered plugs 83 are then screwed up into the sockets 82 which spread the threaded elements 77 into tight frictional engagement with the sleeves 76.

The above operations are of course performed before the insertion of the closure discs 49 into the blade sleeves. These may now be inserted, first inserting the sealing gasket 51, then the disc 49, and finally the snap ring 50.

From the foregoing it will be seen that we have provided a propeller which incorporates various improvements in structure which leads to the efficiency of the unit and, while only the preferred structure is set forth, it will be appreciated that equivalents for the structural elements may be substituted for those disclosed without departing from the spirit and scope of the following claims.

We claim:

1. In a propeller construction, a hub having a tubular shaft coupling element extending transversely therethrough and a blade mounting socket extending radially outward from said element, a blade receiving sleeve rotatably mounted in the socket, a peripheral flange on the inner end of the sleeve, anti-friction bearing means on the sleeve and engaging the flange, means in the socket and engaging the bearing means to block outward displacement of the sleeve from said socket, and loading means interposed between the shaft coupling element and sleeve for pressing the latter outward in said socket to preload said bearing, said loading means including a first part engaging the shaft coupling element, a second part engaging the first part and including an anti-friction bearing engaging said sleeve, and means for adjusting one part relative to the other part to thereby adjust the pressure exerted by the loaded means.

2. In a propeller construction, a hub having a tubular shaft coupling element extending transversely therethrough and a blade mounting socket extending radially outward from said element, a blade receiving sleeve rotatably mounted in the socket, a peripheral flange on the inner end of the sleeve, anti-friction bearing means on the sleeve and engaging the flange, means in the socket and engaging the bearing means to block outward displacement of the sleeve from said socket, and loading means interposed between the shaft coupling element and sleeve for pressing the latter outward in said socket to preload said bearing, said loading means including a pair of resilient cupped disc members having their concave sides facing each other with their peripheral edges in engagement, the convex face of one disc engaging the shaft coupling element, an anti-friction bearing engaging the inner end of said sleeve, and the second cupped disc having its convex face engaging the last named anti-friction bearing.

3. In a propeller construction, a hub having a tubular shaft coupling element extending transversely therethrough and a blade mounting socket extending radially outward from said element, a blade receiving sleeve rotatably mounted in the socket, a peripheral flange on the inner end of the sleeve, anti-friction bearing means on the sleeve and engaging the flange, means in the socket and engaging the bearing means to block outward displacement of the sleeve from said socket, and loading means interposed between the shaft coupling element and sleeve for pressing the latter outward in said socket to preload said bearing, said loading means including a pair of resilient cupped disc members having their concave sides facing each other with their peripheral edges in engagement, the convex face of one disc engaging the shaft coupling element, an anti-friction bearing engaging the inner end of said sleeve, the second cupped disc having its convex face engaging the last named anti-friction bearing, and shim means interposed between said first named disc and the shaft coupling element for adjusting the pressure exerted by said resilient discs.

4. In a propeller construction, a hub having a tubular shaft coupling element extending transversely therethrough and a blade mounting socket extending radially outward from said element, a blade receiving sleeve rotatably mounted in the socket, a peripheral flange on the inner end of the sleeve, anti-friction bearing means on the sleeve and engaging the flange, means in the socket and engaging the bearing means to block outward displacement of the sleeve from said socket, and loading means interposed between the shaft coupling element and sleeve for pressing the latter outward in said socket to preload said bearing, said loading means including a pair of resilient cupped disc members having their concave sides facing each other with their peripheral edges in engagement, the convex face of one disc engaging the shaft coupling element, an anti-friction bearing engaging the inner end of said sleeve, the second cupped disc having its convex face engaging the last named anti-friction bearing, shim means interposed between said first named disc and the shaft coupling element for adjusting the pressure exerted by said resilient discs, and spacer means interposed between said discs.

5. In a propeller construction, a hub having a tubular shaft coupling element extending transversely therethrough and a blade mounting socket extending radially outward from said element, a blade receiving sleeve rotatably mounted in the socket, a peripheral flange on the inner end

of the sleeve, anti-friction bearing means on the sleeve and engaging the flange, means in the socket and engaging the bearing means to block outward displacement of the sleeve from said socket, and loading means interposed between the shaft coupling element and sleeve for pressing the latter outward in said socket to preload said bearing, said loading means including an anti-friction bearing engaging the inner end of said sleeve, a tubular member engaging said bearing, a second member engaging the shaft coupling element and in engagement with the first member for longitudinal adjustment with respect thereto, and means for fixing the adjusted position of said members.

6. In a propeller construction, a hub having a tubular shaft coupling element extending transversely therethrough and a blade mounting socket extending radially outward from said element, a blade receiving sleeve rotatably mounted in the socket, a peripheral flange on the inner end of the sleeve, anti-friction bearing means on the sleeve and engaging the flange, means in the socket and engaging the bearing means to block outward displacement of the sleeve from said socket, and loading means interposed between the shaft coupling element and sleeve for pressing the latter outward in said socket to preload said bearing, said loading means including an anti-friction bearing engaging the inner end of said sleeve, a tubular member engaging said bearing, a second member mounted upon the shaft coupling element, and a third member in threaded engagement with the last mentioned member and also in engagement with the tubular member, the third member being slit longitudinally and having a tapered and screw threaded longitudinal bore, and a tapered screw member in said bore for spreading the second member into close frictional engagement to fix the adjusted position of said second and third members.

PAUL F. HACKETHAL.
ROMUALD KAREY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,069,846	Pecker	Feb. 9, 1937
2,107,785	Grabarse	Feb. 8, 1938
2,275,361	Godfrey	Mar. 3, 1942
2,396,630	Anderson	Mar. 19, 1946
2,425,938	Hoover	Aug. 19, 1947
2,436,612	Sheets	Feb. 24, 1948