S. HART & R. I. EUSTIS.

ADJUSTABLE PROPELLER.

APPLICATION FILED SEPT. 10, 1917. RENEWED MAR. 4, 1919.

1,301,052. Patented Apr. 15, 1919.

Fig. 1.

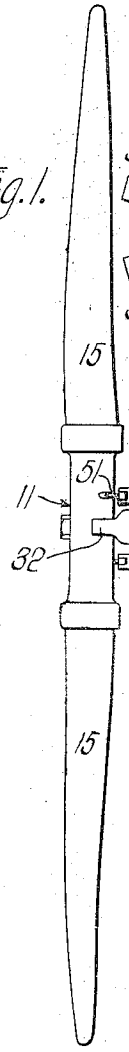


Fig. 3.

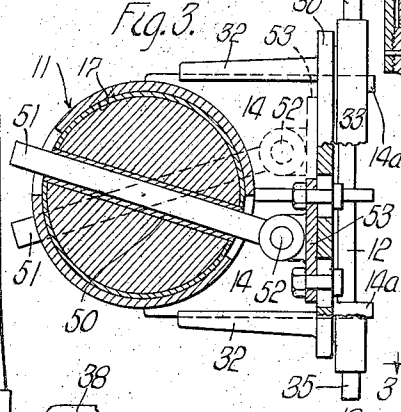
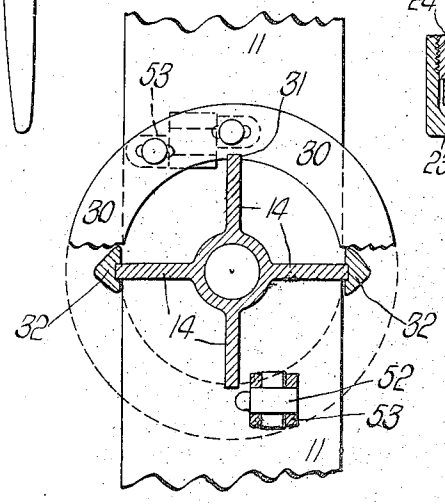


Fig. 2.

Fig. 4.



Inventors
Seth Hart and
Robert I. Eustis,
by James T. Bandelow
their Attorney.

UNITED STATES PATENT OFFICE.

SETH HART AND ROBERT I. EUSTIS, OF LOS ANGELES, CALIFORNIA.

ADJUSTABLE PROPELLER.

1,301,052. Specification of Letters Patent. Patented Apr. 15, 1919.

Application filed September 10, 1917, Serial No. 190,527. Renewed March 4, 1919. Serial No. 280,661.

To all whom it may concern:

Be it known that we, SETH HART and ROBERT I. EUSTIS, citizens of the United States, residing at Los Angeles, in the county of Los Angeles, State of California, have invented new and useful Improvements in Adjustable Propellers, of which the following is a specification.

This invention relates to propellers and particularly to adjustable or feathering propellers, and more particularly to such propellers designed for use on air craft; although, it will be understood that our invention is applicable to propellers used in any medium.

For the purpose of describing our invention we herein explain a form of device particularly useful for airplanes, although it will be understood that our invention is not limited to such use.

In airplanes and the like it is desirable that the pitch should be capable of being changed—that the angularity of the propeller blades should be capable of being changed under the control of the aviator. We have found by actual trial and demonstration that an adjustability of propeller pitch is an exceptionally desirable thing and produces very excellent results because it enables an airplane to have great starting power and also to have high speed. Heretofore all airplanes have been equipped with propellers of a pitch designed to give as good starting speed as possible and at the same time to give as high traveling speed as possible. It is, of course, impossible to design a fixed pitch propeller so that it has the maximum efficiency for both these things; and so in actual practice the pitch of the propeller is fixed by a compromise. With an adjustably pitched propeller it is possible, and with our device it is thoroughly practical, to decrease the pitch when the machine is starting, enabling the machine to make a quick get-away; and to increase the pitch when the machine is flying, thus materially increasing the speed of flying with a given amount of power and at the same time decreasing the engine speed. In actual tests we have been able to add as much as thirty per cent. to the speed of an airplane and at the same time to decrease the engine speed enough to materially reduce the engine vibration and add to the life of the engine.

It is an object of this invention to provide a simple and effective means for changing the pitch of the propeller blade; to provide a means which is accurate, safe, and trustworthy; one that does not weaken or otherwise have a detrimental effect upon the propeller construction itself; and also one which embodies a self-locking feature, and will hold the propeller blades in any adjusted position without any strain having to be borne by any part of the connective mechanism.

Our invention is characterized by the use of a sliding tilting rod which engages the propeller blade, the blade being adjustably revoluble about an axis longitudinal of itself. Although it may be immaterial just where the sliding takes place, in practice we prefer to let the tilting rod slide through the blade base, the base being preferably rotatably mounted in a socket and preferably provided with an end thrust ball bearing to take the end thrust due to centrifugal force. The tilting rod has its end connected to a member movable to and from the blade, and normally stands in a position at an angle to the line of said movement. Said member is preferably a slider movable longitudinally of the shaft; and longitudinal movements thereof cause relative sliding movement of the tilting rod and change the angular position of that rod and, thereby, the position of the blade.

We illustrate a preferred form of device in the accompanying drawings wherein Figure 1 is an elevation of our improved propeller; Fig. 2 is an enlarged longitudinal section of the central working parts of the propeller; Fig. 3 is a cross section taken as indicated by line 3—3 on Fig. 2; and Fig. 4 is section taken as indicated by line 4—4 on Fig. 2.

In the drawings we show a propeller shaft at 10. In the preferred form of our improved propeller we provide a central socket member 11 which may be mounted upon and connected to the shaft 10 by means of bolted flanges 12 and 13. The flange 12 may preferably be formed integrally with the socket

member 11; and, in our preferred construction, there are four reinforcing and way flanges 14 which extend from the flange 12 to the socket member 11 and may, if desired, overhang the flange 12 as shown at 14ª so as to provide the desired length of way and at the same time allowing the flange 12 to be close to the socket member 11.

Our construction requires that the propeller blades 15 be so mounted upon the central member 11 as to be adjustably revoluble about their longitudinal axis or about an axis parallel to their longitudinal axis. This arrangement we preferably accomplish by socketing the bases 16 of the propeller blades within the oppositely projecting sockets of member 11. The sockets are not necessarily set opposite each other. We prefer this form, although any other suitable construction may be used whereby the propeller blades may be adjusted in the manner herein stated. Preferably we provide each base blade 16 with a sleeve 17 having a revolving fit in the socket 11. This sleeve 17 is permanently set upon blade base 16; and this may be accomplished by enlarging the bore of the sleeve at its inner end, as shown at 18, by driving into the wood of the propeller blade a tubular wedge 19 which causes the inner end of the base to expand in the manner indicated in the drawings. The sleeve 17 fits the base tightly and fits in the socket 11 as closely as possible consistent with free revolution.

To take care of the outward end thrust due to centrifugal force, we provide end thrust ball bearings 20 which operate between a race ring 21 set upon the enlarged end 22 of sleeve 17 and a race ring 23 which has a screw threaded mounting at 24 on to the end of socket 11; and a pin, as shown at 25, or any other suitable means may be used, to prevent race ring 23 unscrewing from position. The race ring 21 has a conical bearing on the end 22 of sleeve 17 so that it is automatically self-centering.

Upon the longitudinal way flanges 14 we mount a slider 30 which is preferably in the form of a ring having notches as shown at 31 which engage the outer edges of the ways 14; and on two opposite sides this slider ring may have extended bosses 32 which provide extended bearings along two of the opposite way flanges 14. Now, although we describe this slider as preferably directly mounted upon flanges 14 which form a part of the central socket member of our device, yet this slider 30 may be slidably mounted on the shaft 10 in any suitable manner. Longitudinal movement of the slider causes the tilting movement of the blades in the manner hereinafter described. This longitudinal sliding movement is obtained through the medium of a non-revolving ring 33 connected with the slider 30 through the interposition of a ball bearing 34. This ball bearing may be, and preferably is, both a radial and end thrust bearing. The non-revolving ring 33 is connected by pins 35 with a yoke 36. One side of this yoke 36 is pivoted upon a pin 37 mounted upon any convenient stationary bracket, as 38; and the other side of the yoke is pivotally connected at 39 with a screw-threaded rod 40 threaded into a nut 41 preferably pivotally mounted at 42. A swivel joint 43 is used on the rod 40 so that the rod may be rotated in the nut 41 to accurately adjust its longitudinal position and thus adjust the position of the yoke 36 and the longitudinal position of slider 30. The screw-threaded rod 40 may be rotated through the medium of any convenient connection, such a flexible shaft 44 extending back to the operator's seat.

Each of the blade bases 16 has a bearing sleeve 50 extending transversely therethrough, this bearing sleeve being preferably set in the sleeve 17 of the blade base 16; and a tilt-rod 51 slides through each bearing sleeve. These tilting rods stand in opposite diagonal relation to each other as is best shown in Fig. 5; and their ends are pivotally connected at 52 with the slider 30. This pivotal connection may be effected by making the pivotal connection 52 to brackets 53 adjustably mounted on the slider ring 30; the brackets being adjustable parallel to the plane of the section in Fig. 3; so that by adjustment of the brackets a general permanent adjustment of the amount of tilt of rods 51 may be effected.

When the slider 30 is moved longitudinally and the pivotal points 52 are moved to or from the blades, the rods 51 have a longitudinally sliding movement and at the same time change their angular position. The amount of angular change depends upon the normal angularity of rods 51 and also upon the amount of movement of slider 30; and we find that it is not necessary to give the rods 51 a great amount of normal augularity in order to effect an adjustment movement of suitable amount. Thus, with the rods in about the position shown in Fig. 3, a relatively large sliding movement is necessary to substantially change the angular adjustment; and the result of this arrangement is that, although the blades are very easily angularly adjusted (and this is particularly true on account of the end thrust bearing at 20) yet no amount of pressure upon the blades themselves tending to displace them from their proper angular position will cause the sliding or longitudinal movement of rods 51 and slider 30. In other words, the sliding mechanism is self-locking in any position where it may be placed. This ease of adjusting movement and the fact that the operator has a great leverage over any force which tends to op-

pose the adjusting movement of the blade, allows of a very fine and accurate blade adjustment. By revolving the screw 40 the operator gradually and smoothly changes the pitch of the blade. Furthermore, the self-locking feature of the device prevents any strain at all being imposed upon any of the parts other than the tilting rods 51 and the slider 30; all strain being kept off the connective parts 36, 40, 44, etc. In fact, the propeller blades may be so designed that there is very little force exerted tending to move the blades from any position in which they may be placed. But even this small force is transmitted no farther than the slider 30. The ball bearings at 34 are under no strain except during adjustment. When the movement is completed and the yoke 36 is at rest, then whatever pressure there was on the bearings during the adjustment is immediately relieved because of the fact that any vibration or pressure however slight, which has any tendency to move the blades can only move them in the same direction as that in which the previous adjustment took place.

It will be seen that a distinctive feature of this mechanism is embodied in the tilting rods which operate between the slider and the revoluble blades; having a pivoted or swinging connection at one end and the sliding connection at the other end. For purposes of convenience in construction and operation we prefer to make the pivotal connection at the slider end of each tilting rod and to have the rods slide through the blade; but this arrangement may be reversed, if desired.

Further, our device is not limited in its application to a two blade propeller. It may be applied to any number of blades; for instance to a propeller of four blades; and where more than one pair of blades is used the blades, the pairs of blades may be set in different planes of revolution (one set may be a little farther along the shaft than another) so that all the blades do not rotatably cut through the same plane. And, although we illustrate our propeller as a "tractor" or "puller" propeller, it may be readily converted into a "pusher" by simply withdrawing the rods 51 and turning each blade over in its socket (turning each blade on its own longitudinal axis through 180°) and then replacing the rods 51. This is an advantageous feature due to the blades being rotatable about their own axes.

The normal angularity of the blades—their "pitch"—and their angularity at each extremity of adjustment will depend of course on the relative setting of the blades and the tilting rods and on the amount of angular adjusting movement given by the tilting rods. The arrangement may enable the blades to be brought in fact to the zero angle—the position of no pitch—and even to reverse the pitch for purposes of slowing down the airplane after landing, etc.

Although we have described a preferred form of our device with some particularity we do not thereby limit ourselves. Various changes may be made in the specific construction, to adapt the device to different situations, etc., without exceeding our invention as set forth in the following claims.

Having described a preferred form of our invention, we claim:

1. In combination, a propeller shaft, a propeller blade mounted on the shaft to be adjustably revoluble about an axis longitudinal of the blade, a sliding member rotating with and slidable longitudinally of the shaft, and a tilting rod for the blade slidingly engaging the blade and pivotally connected with the sliding member, said pivotal connection being adjustable on the sliding member so as to adjust the normal position of the tilting rod and of the blade.

2. In combination, a propeller hub member having blade receiving sockets, blades mounted in the sockets to be rotatably adjustable therein about axes parallel to the blades, a shaft upon which the hub member is mounted, a guide structure integral with the hub member concentric around the shaft and projecting from the hub member parallel with the shaft, a slider on the guide structure slidable thereon and non-rotative with relation thereto, and diagonal slidable tilting rods pivotally attached to the slider and extending through the portions of the blades within the sockets, the sockets having slots through which the rods may pass.

3. In combination, a propeller shaft and a hub member having a radial blade receiving socket, a propeller blade having a base revolubly fitting in the socket, an end-thrust bearing at the outer end of the socket to take the end-thrust of the blade due to centrifugal force, a bearing sleeve extending transversely through the blade base between the ends of its bearing in the socket, a slider on and revoluble with the shaft, and an angularly disposed tilting rod pivoted to the slider and sliding through the bearing sleeve through the blade base, the socket being slotted to pass the rod.

4. In combination, a propeller shaft and a hub member having a radial blade receiving socket, a propeller blade with a base, a bearing sleeve rigidly mounted on the base and revolubly fitting in the socket, an end thrust bearing at the outer ends of the socket and bearing sleeve, a transverse bearing sleeve extending through the blade base and the first mentioned bearing sleeve between the ends of the socket, the socket being slotted opposite the transverse bearing sleeve, a slidable angularly disposed tilting rod passing through the socket slot and slidable through the transverse bearing sleeve,

a slider on and revoluble with the shaft, and pivotal connection between the slider and the rod.

5. In combination, a propeller shaft and a hub member having a blade receiving socket, a propeller blade having a base revolubly fitting in the socket, an end-thrust bearing to take the end thrust of the blade due to centrifugal force, the blade base having a transverse tilting rod passage through it between its ends and between the ends of the socket and the socket having a slot registering with the said passage, a slider revolving with the shaft and movable longitudinally thereof, and an angularly disposed tilting rod pivoted to the slider and sliding through the passage in the blade base and through the socket slot.

6. In combination, a propeller shaft and a hub member having a blade receiving socket, a propeller blade having a base revolubly fitting in the socket, an end thrust bearing to take the end thrust of the blade due to centrifugal force, a slider revolving with the shaft and movable longitudinally thereof, and a tilting rod normally at an angle to the line of movement of the slider and connected at one end with the slider and connected at the other end with the blade base at a point between its ends and between the ends of the socket, one of said connections of said rod being a longitudinally sliding connection.

7. In combination, a propeller shaft, a propeller blade mounted on the shaft to be adjustably revoluble about an axis longitudinal of the blade, a sliding member rotating with and slidable longitudinally of the blade, a sliding member rotating with and slidable longitudinally of the shaft, and a tilting rod for the blade connected at one end with the blade and at the other end with the sliding member, one of said connections of said rod being a longitudinal sliding connection, and one of said connections of said rod being adjustable independently of the adjustment in the sliding connection so as to adjust the normal position of the propeller blade.

In witness that we claim the foregoing we have hereunto subscribed our names this 4th day of September and 28th day of August, 1917.

SETH HART.
ROBERT I. EUSTIS.

Witness:
JAMES T. BARKELEW.