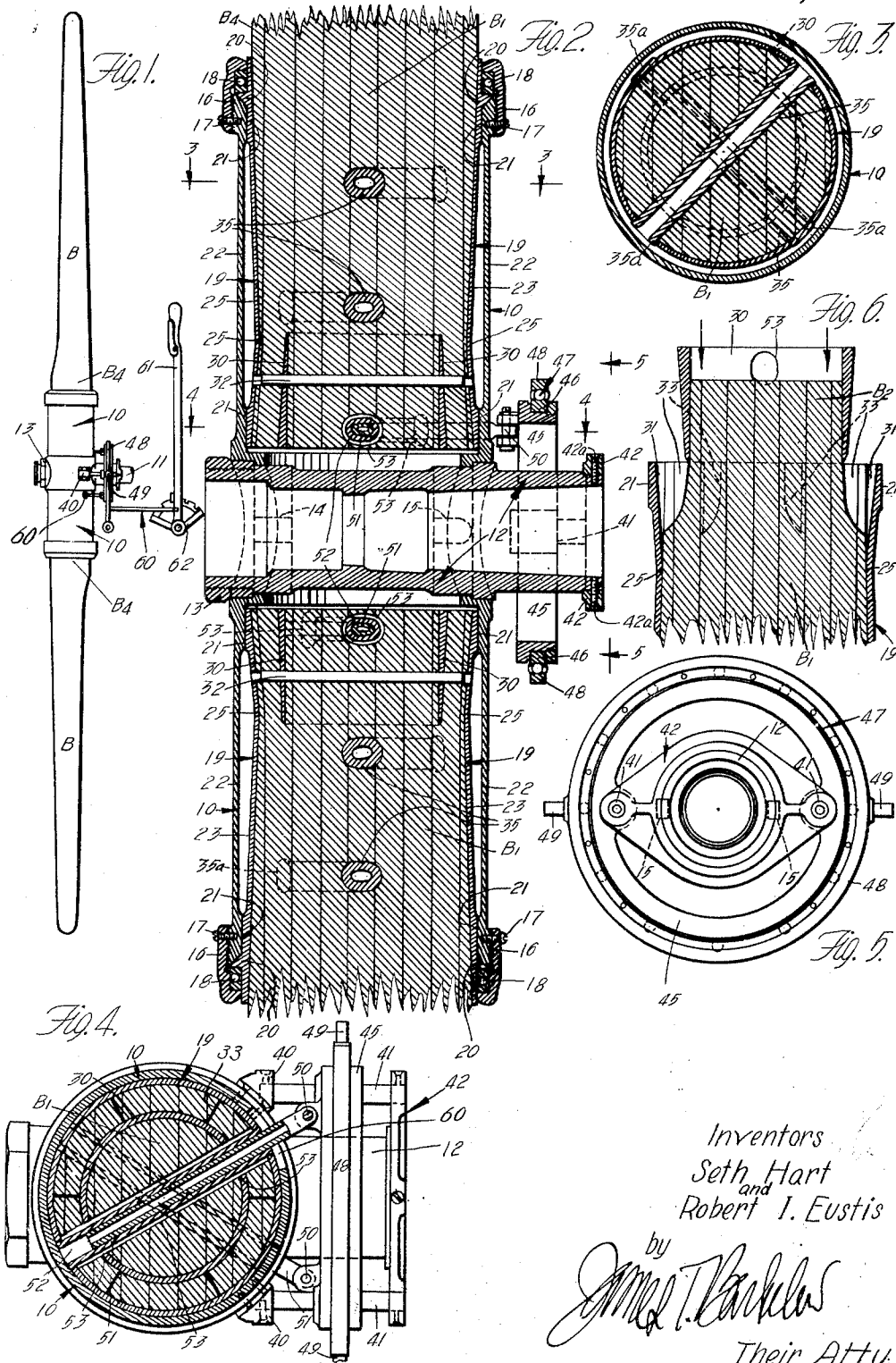


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ADJUSTABLE PROPELLER.
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1,366,074.

Patented Jan. 18, 1921.



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ADJUSTABLE PROPELLER.

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Specification of Letters Patent.

Patented Jan. 18, 1921.

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To all whom it may concern:

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

This invention relates to adjustable propellers and the like, such as shown in our Patent No. 1,301,052, dated Apr. 15, 1919; and it is the object of the present invention to provide certain improvements in detail structure of such devices; and particularly to provide an effective means for holding wooden or other propeller blades in ferrules or sleeves or the like, at their base ends. The method herein described of holding wood or the like in a ferrule or sleeve may be broadly applied to any situation; but it is specifically applicable and advantageous in an adjustable propeller of the character herein described. However, it will be readily understood that such a method of mounting and holding wood or other material of the propeller blade may be applied for instance, to a propeller blade which is not necessarily adjustable. In any kind of a propeller (or in any structure, for that matter) the provision of an effective and reliable means for holding the base of a blade in a socket, makes it possible to use shorter pieces of wood than would otherwise be possible and this is an advantage in itself regardless of the adjustability or non-adjustability of the blade. Furthermore, such a provision makes it possible to replace a damaged blade without having to replace the whole propeller; the blades being made to standard sizes and each balanced against a master blade so as to be ready for replacement use at any time.

With regard to the features of this invention which have to do more particularly and specifically with the propeller being adjustable, it may be well here to point out certain advantages inherent in such an adjustable propeller. Arrangement may be made such that the pitch of the propeller may be adjustable either through a range entirely "positive"—that is, through a range which merely varies the pitch of the propeller without carrying it to or through the zero

or neutral point; or the range of adjustability may be made to carry the propeller to or even through the zero or neutral point. In the latter mentioned case the propeller of course reverses in action and will immediately act as a positive brake on the forward movement of an airplane. Of the advantages inherent in the changing of forward pitch of the blade it is not necessary to speak at length; the pitch may be shortened to give quick gathering of speed and quick get-away and also ability to climb at a sharp angle; may be lengthened for fast travel; or may be extremely lengthened when traveling with the wind or when traveling downwardly when excessive speed is desired. In other words, the pitch of the propeller may be adjusted to always be in keeping with the maximum power of the engine under varying loads. But the reversibility of the propeller is an item of very great importance particularly in avoiding accidents, collisions, etc., and particularly in enabling an airplane to land successfully in a small space; the propeller being reversed to apply a positive brake upon the forward movement of the plane, either while in the air or after landing and while running upon the surface. And the reversible feature is of great importance in dirigible balloons, to enable them to maneuver quickly, to stop quickly over an objective, etc.

It will be understood that wherever we speak of wood as the material of which the blades are made, we do not mean that the invention is applicable only to that specific substance. The blades may be of any other suitable material; and our invention is applicable wherever the blade material requires or makes desirable the kind of blade mounting, or material connection, as herein described.

The construction hereinafter explained in detail is one which is particularly applicable to the objects hereinabove set forth, and is peculiarly efficient in accomplishing each and all of these objects. The claims of this application are more particularly directed to the wood holding means and to such means in combination with a propeller of the general type described; while the claims in said application are directed to the general pitch

varying structure without limitation to the wood holding means.

For the purpose of such detailed description we refer to the accompanying drawings in which—

Figure 1 is an elevation of our improved propeller; Fig. 2 is an enlarged longitudinal central section of the hub portion of the propeller; Fig. 3 is a cross-section on line 3—3 of Fig. 2; Fig. 4 is a cross-section on line 4—4 of Fig. 2; Fig. 5 is a view taken as indicated by line 5—5 on Fig. 2; and Fig. 6 is a sectional view illustrating the method of assembly of the wood-holding means.

Referring now particularly to the drawings it will be seen that we show at 10 a tubular member which we may call the hub member of the propeller. In order to mount this hub member upon the propeller shaft or engine shaft, indicated at 11, we provide a bushing at 12. This bushing 12 is interiorly bored to take any given propeller or engine shaft; in practice standard bushings are made to fit the various engines or propeller shafts and these bushings, while of course they have various interior bores, have a standard exterior configuration to fit any given hub member 10. These bushings are drawn into place with a nut 13 and are held also by keys 14 and 15. This method of mounting the bushing provides for a perfectly tight and rigid connection between the bushing and the hub member so as to eliminate all possibility of looseness developing by vibration. In order to mount this propeller upon any given airplane it is only necessary to provide the appropriate bushing; all the other parts of the propeller are of standard design.

The hub member 10 is substantially cylindrical in form and carries at each end an end-thrust collar 16 screw-threaded upon member 10 and held against unscrewing by any suitable means, such as a screw or screws as illustrated at 17. This collar 16 houses an end-thrust ball bearing 18 and the base ferrule 19 of the propeller blade has a collar 20 thrusting against the end thrust bearing 18. The blade base B¹ is made cylindrical for a short distance outside the end of the hub member, at B⁴, so that collar 20 may be lifted far enough to get at the end thrust bearing without having to move the blade and ferrule 19 outwardly. At the outer end of the hub member, and immediately adjacent the end thrust bearing, ferrule 19 has a radial bearing surface at 20 in the hub member; and at its inner end the ferrule has another radial bearing surface at 21 in the hub member. Between these two radial bearing surfaces the inner surface of the hub member is relieved as shown at 22; and the exterior surface of the ferrule 19 is also relieved in-

wardly as shown at 23. All of the parts just spoken of are, in this particular form of two-bladed propeller, provided of course in duplicate. It will be readily understood that the invention may be applied to a propeller of any number of blades.

The ferrules may be made in the shape and design shown in the drawing. From their outer ends they may taper inwardly to a medial point 25 which may be located nearer their inner ends than their outer ends and from their inner ends they taper also to the point 25. The blades B are prepared with bases B¹ of a proper size and configuration to be pushed under heavy pressure into the ferrules. The ferrules may be expanded, by heating to a temperature not high enough to injure the wood; and allowed to cool and shrink around the wood to give additional compression, if desired. The base of the blade may have a tapering part corresponding with the outer long taper of the ferrule and at its end the blade has a part which initially is straight or cylindrical. This is illustrated in Fig. 6. The taper from the outer end of the ferrule may be made very slight, or it may be entirely dispensed with and that part of the ferrule and blade base made cylindrical. It is the inner end taper that takes the strain due to centrifugal force; the fitting of the blade base in the outer part of the ferrule is mainly for the purpose of carrying the torque strain. When the blade is initially made its base has on its end a round stub B², concentric with the base of the blade and adapted to form a centering guide for the annular wedge 30 which is then driven into the end of the blade base, to its final position shown in Fig. 2. When this annular wedge is driven into place it expands the end of the blade base and makes the end of the blade base tightly fit the inner conical part of the ferrule. The initial space shown at 31 in Fig. 6 is smaller than the section of the wedge and the wedge is driven in under great pressure; so that when the wedge is in position it very tightly wedges the expanded end of the blade base into the conical expanded inner part of the inner end of the ferrule. When the wedge is in place then a small dowel pin 32 is set through the wood and through the wedge, but preferably not through the ferrule walls, so as to hold the wedge immovable in the wood and keep it from working out the wood; causing the wedge to always keep in its proper fixed position with relation to the wood even if the wood should afterward move slightly in the ferrule. When the wedge has been put in place the stub B² is then cut off. In order to make the outer parts of the wood around the wedge split evenly, it is usual to make a suitable number of evenly spaced saw cuts

33 around the end portion of the base B¹ as is indicated in Fig. 6. This causes the wood to split evenly and causes an even transmission of the wedging stress completely around the blade base. The accurate centering of the wedge conduces to this desired end; and also prevents any breaking of the split expanded parts from the blade base; these parts being of uniform thickness and split uniformly.

It will be seen that the above described means are broadly means for wedge-fitting the wood into a receiving member (the ferrule) in such a way that the wood is under compression and wedged tightly against longitudinal movement under the strains imposed on it. Therefore we do not limit this part of our invention to the specific construction and arrangements herein set forth but only to such means as may be used to effect the certain results here broadly stated.

A suitable number of dowel pins are then put through the base B¹ and ferrule 19. Preferably we place two such pins through each blade base and these pins, as shown at 35, are preferably placed at right angles to each other and are each at an angle of 45° to the laminations of the wood of which the propeller blade is made. These dowel pins are preferably of fairly large size so as to give good bearing surface upon the wood and are also preferably hollow and are swaged or riveted out at their outer ends as indicated at 35^a at the exterior surface of the ferrule so as to hold the dowel pins securely in place. Although the wood is held tightly and rigidly from any movement of any extent by reason of its being wedge-fitted into the ferrule in both directions; yet the dowel pins are placed also for the purpose of preventing any incipient longitudinal movement of the wood in the ferrule. The dowel pins are not primarily designed for the purpose of taking the major longitudinal stresses due to centrifugal action; the wedge-fitting of the wood into the ferrule takes those major stresses; but the dowel pins perform the function of an additional safety lock for the wood. They also provide an additional positive keying of the wood in the ferrule as regards rotation.

After the wood is set in the ferrule, the ferrule is exteriorly finished to its proper and accurate dimensions; the inter-engaging surfaces of the hub member and of the ferrule being ground very accurately, so that the ferrule fits rotatably in the hub, but with no looseness to afford any room for vibration.

Hub member 10 carries a pair of small brackets 40 and tubular guides 41 are set in these brackets, these guides 41 extending parallel with the propeller shaft and being

supported at their outer ends by a supporting member 42 which is mounted upon the bushing 12. Member 42 may be secured by pins 42^a against turning on the bushing; and this member may be removable from the bushing for the purpose of making bushing substitutions. A slider ring 45 is slidably mounted on guides 41. This slider ring carries the inner race member 46 of a ball bearing 47, which is preferably both a radial and end thrust bearing. The outer race 48 of this bearing has trunnions 49 through the medium of which a connection may be made to any suitable controlling mechanism; such as a manually operated mechanism of any suitable kind. It is not necessary here to describe any particular manually operated mechanism for moving the slider back and forth; any suitable leverage or other system, such as commonly used, may be used here; such as the ordinary leverage system illustrated at 60, including a hand lever 61 and a notched sector 62. Such an arrangement allows the slider to be moved quickly and positively from one position to another.

On the slider 45 pivots 50 are mounted and to these pivots the tilting rods 51 are connected. The function of these tilting rods is substantially the same as described in our said prior application. The tilting rods are now preferably hollow, so as to give the greatest transverse strength for the least weight of material; and these tilting rods slide through guide tubes 52 which extend through the wood of the blade bases at their inner ends; extending also through the wedges 30 and being rigidly and strongly set at their outer ends in ferrules 19. This is best illustrated in Fig. 4. By placing the tilting rods close to the inner ends of the blade bases, the slider and tilting rod construction is made compact and strong; the slider ring 45 being thus of a minimum diameter. Where the tubular guides 52 pass through the wedges 30, and through the wood base B¹, the wedges and wood are provided with openings 53 to pass the guide tube more or less freely, and these openings are also somewhat elongated as shown in Figs. 2 and 6, so that any slight relative movement of the wood and wedge will not cause any bending or binding of guide tubes 52. The guide tubes are therefore always perfectly straight and form a perfectly true guide for the tilting rods 51.

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

1. In a device of the character described and in combination, a hub having a blade receiving socket, a blade having a base, a bearing ferrule fitting around the base of the blade and revolubly fitting into the socket, said ferrule having a tapered bore at one end thereof, means for permanently and

rigidly securing the blade base in the bearing ferrule embodying a circular wedge in the end of the base adapted to expand the base within the tapered bore of the ferrule, and end-thrust means to hold the bearing ferrule endwise in the socket and allow its rotation therein.

2. In a device of the character described and in combination, a hub member having a blade receiving socket, a blade having a base, a bearing ferrule fitting around the base and revolubly fitting into the socket, said ferrule having an enlarged tapering bore at one end, means for permanently and rigidly securing the blade base against movement in the ferrule embodying a circular wedge in the end of the base expanding the latter in the tapered end bore of the ferrule, and a collar on said socket having a flange adapted to serve as an end-thrust means to hold said ferrule endwise in the socket and allow its rotation therein.

3. In a device of the character described and in combination, a hub member having a blade receiving socket, a blade having a base, a bearing ferrule fitting around the base and revolubly fitting into the socket, said ferrule having an enlarged tapering bore at one end, means for permanently and rigidly securing the blade base against movement in the ferrule embodying a circular wedge in the end of the base expanding the latter in the tapered end bore of the ferrule, a collar on said socket having a flange, roller bearings between said flange and the end of said ferrule adapted to serve as an end-thrust means to hold said ferrule endwise in the socket and allow its rotation therein.

4. In a device of the character described, and in combination, a hub member having a blade receiving socket, a blade having a base, a bearing ferrule fitting around the base and revolubly fitting into the socket, means piercing the blade base and compressing the blade material against the ferrule to rigidly secure the blade base in the bearing ferrule, and means for holding the bearing ferrule against endwise movement in the socket.

5. In a device of the character described and in combination, a hub member having a blade receiving socket, a blade having a base, a bearing ferrule fitting around the base and revolubly fitting into the socket, means for rigidly securing the blade base in the bearing ferrule against movement therein, said means including means to cause wedging and expansion of the base in the ferrule, and means to hold the bearing fer-

rule against endwise movement in the socket.

6. In a device of the character described, a blade having a base, a substantially cylindrical receiving member for the base, the interior of said member being conically tapered from one end to a medial point and the base being forced under pressure into the receiving member from the other end, and wedge means set in the end of the base to expand it to compressively fill said conically tapering part of the receiving member.

7. In a device of the character described, a blade having a base, a substantially cylindrical receiving member for the base, the base being forced under pressure into the receiving member from one end, the interior of the receiving member tapering from the other end to a medial point, wedge means set in the end of the base to expand it to compressively fill said conically tapering part of the receiving member and a pin set transversely through the base and through the wedge means to hold the wedge immovable with respect to the base.

8. A device for holding wood or the like embodying a ferrule tapering interiorly from one end to a medial point, the wood or the like being forced into the ferrule, annular wedge means set in the wood or the like at the end to expand that end to compressively fill the tapering portion of the ferrule, transverse holding members set through the wood or the like and set in the ferrule, and a pin set transversely through the base and through the wedge means to hold the wedge immovable with respect to the base.

9. In a device of the character described, and in combination, a hub member having a blade receiving socket, a blade having a base, an endless bearing ferrule increasing in width from a medial point to one end fitting around the base and revolubly fitting into the socket, means piercing the blade base and compressing the blade material against the ferrule at the tapering portion of the ferrule to rigidly secure the blade base in the bearing ferrule, and means for holding the bearing ferrule against endwise movement in the socket.

In witness that we claim the foregoing we have hereunto subscribed our names this 22d day of March, 1919.

SETH HART.
ROBERT I. EUSTIS.

Witnesses:

VIRGINIA I. BERINGER,
VERA E. JONS.