Jan. 18, 1944. J. H. DAVIS 2,339,624

PROPELLER BLADE BALANCING ATTACHMENTS

Filed March 14, 1942

Fig. 1.

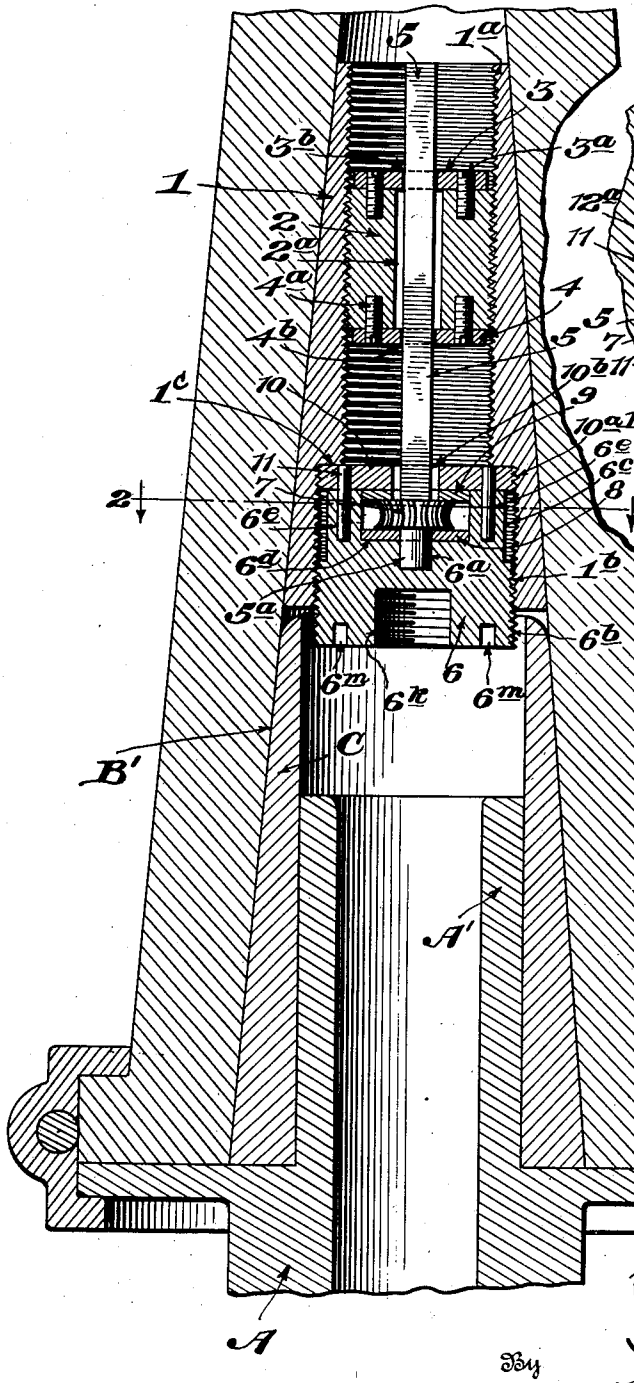
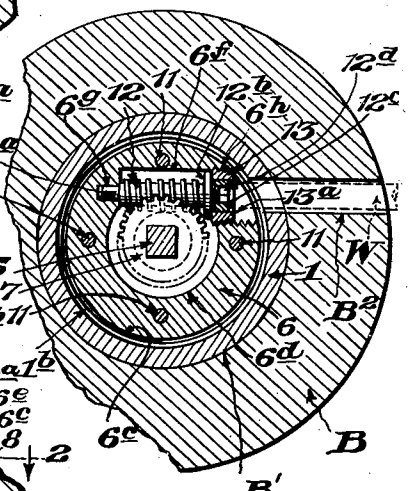


Fig. 2.



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PROPELLER BLADE BALANCING ATTACHMENT

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21 Claims. (Cl. 170—177)

This invention is a novel unitary attachment adapted to be mounted in the customary tapered bores at the inner ends of the shanks of airplane propeller blades for the purpose of effecting balance of the assembly of propellers on the hub; and the principal object thereof is to provide a simple, novel and efficient attachment which may be inserted as a unit in such propellers, and which may be removed as a unit and salvaged in event of damage to the propeller and thereby re-used repeatedly for effecting the balance of a propeller and hub assembly.

Another object of the invention is to provide a balancing unit for insertion in the tapered bores of the shanks of propeller blades, which attachment can be manufactured at a place far distant from the place of manufacture of the blades themselves, and can be readily mounted in a few minutes in the blade by any mechanic supplied with a jig, since all that is required of the mechanic is to insert the unit in the blade and drill a bore through the wall of the blade to receive an Allenhead wrench, the location of the bore on the exterior of the blade being determined by the jig; and said unit being thus mounted in the bore without the use of extraneous fastening devices, and requiring no additions to the actual propeller blade other than the drilling of the bore for the Allenhead wrench used to adjust the balancing weight of the unit from the exterior of the shank of the propeller blade.

A still further object of the invention is to provide a novel means on the head of the shell for preventing centrifugal force from pulling the worm gear out of mesh with the worm; said head being further provided with means for removing the unit from an injured propeller blade in order that the unit may be mounted for re-use in another propeller.

Other minor objects of the invention will be hereinafter set forth.

I will explain the invention with reference to the accompanying drawing which illustrates one practical embodiment thereof to enable others familiar with the art to adopt and use the same; and will summarize in the claims the novel features of construction, and novel combinations of parts, for which protection is desired.

In said drawing—

Fig. 1 is a vertical section through the lower portion or shank of a propeller blade showing the upper portion of the hub engaged therewith, and showing my novel balancing unit in operative position within the tapered bore of the blade.

Fig. 2 is a horizontal section on the line 2—2, Fig. 1.

The propeller hub A is provided in the usual manner with a blade supporting projection A' adapted to enter the inner end of the tapered bore B' of propeller blade B, a sleeve C being fitted between the projection A' and the tapered bore B', and the propeller being secured to the hub by means of split clamps D or the like. However, the particular means for mounting the propeller blade B on the hub A forms no part of my present invention, and any means other than clamps D may be utilized to give the propeller blade B a solid foundation on the hub A while at the same time permitting the blade B to be rotated around the hub extension A' to effect changing the pitch of the blade while in flight.

Ordinarily the time required to balance a propeller and hub assembly, by present known methods, runs into hours; but I have provided a balancing unit which reduces to minutes the time required for effecting balance of the propeller and hub assembly, said unit being mounted directly within the tapered bore B' of the propeller shank B. As shown, my novel unit comprises a shell 1 having an exterior taper corresponding with that of bore B' in the propeller shank, said shell being adapted to be pressed into the end of bore B' when the blade is dismounted from hub A and to be retained in such position by the tightness of the fit or by any desired means to prevent axial movement of the shell in the bore. Shell 1 is provided with a relatively large threaded bore 1*a* extending from its upper end to a point adjacent the lower end. Below bore 1*a* is an enlarged threaded bore 1*b*, the bores 1*a* and 1*b* forming a shoulder 1*c*, for the purpose hereinafter described.

Threaded into bore 1*a* is a heavy cylindrical weight 2 having exterior threads engaging the threaded bore 1*a*, whereby when weight 2 is rotated the same will be moved axially of the shell 1. Weight 2 is provided with a circular bore 2*a* extending from top to bottom; and fixed upon the upper and lower faces of weight 2 are plates 3 and 4, respectively, secured thereto by studs 3*a* and 4*a* respectively, said plates having non-circular holes 3*b*, 4*b* at their centers, respectively, adapted to snugly fit a non-circular shaft 5 of smaller size than bore 2*a* of weight 2, and said shaft 5 and holes 3*b*, 4*b*, being preferably square. Shaft 5 extends from the upper end of shell 1 down into the enlarged bore 1*b*, the upper end of shaft 5 being held aligned with the axis of shell 1 by means of the plates 3 and 4.

The lower end of shaft 5 is rounded as at 5a to engage a corresponding seat 6a in a head 6 consisting of a substantially cylindrical block having exterior threads 6b at its lower portion engaging the threaded bore 1b of the shell 1, said head 6 being reduced in diameter, as at 6c, adjacent its upper portion. In the upper portion of head 6 is a large circular recess 6d of substantial depth and disposed axially of the head, said recess 6d receiving a worm gear 7 of less thickness than the depth of recess 6d, worm gear 7 being fixedly mounted upon the square shaft 5 in such position that when the lower rounded end of the shaft 5 is positioned in the seat 6a, the gear 7 will be spaced from the upper and lower ends respectively of the recess 6d. At the lower end of recess 6d is a washer 8 having a hole for the circular portion 5a of shaft 5; and within the recess 6d above worm gear 7 is a second washer 9 having a relatively large central hole through which the squared portion of shaft 5 passes, the thickness of the washers 8 and 9 together with the thickness of worm gear 7 being equal to the full depth of recess 6d, the washers 8 and 9 forming bearings engaging the opposite faces of the worm gear 7.

In order to maintain the upper washer 9 in contact with the upper face of worm gear 7, a cap 10 is provided seating across the upper end of head 6, said cap having external threads 10a engaging the threads of bore 1b of shell 1, said cap being provided with a plurality of pins 11 projecting from its underside and entering holes 6e therefore in the top of head 6 whereby cap 10 is caused to rotate by and with the head when threading same into the bore 1b, the cap and head being thus positioned in shell 1 without binding against the threads of bore 1b. Cap 10 is provided with a central opening 10b of sufficient diameter to permit the square shaft 5 to rotate therein.

By the above construction after weight 2 has been threaded into the bore 1a of shell 1, with head 6 removed, the head and shaft may be assembled by placing washer 8 in the lower end of recess 6d, then placing the shaft 5 with the worm gear 7 mounted thereon in position in the seat 6a of the head, then placing the upper washer 9 in position in recess 6d upon the upper face of worm gear 7, and then placing the cap 10 upon the head. Such assembly as a unit is then threaded into the bore 1b until cap 10 is in firm contact with shoulder 1c of shell 1, the shaft 5 passing through the holes 3b, 4b in the plates 3 and 4 of weight 2.

In order to rotate worm gear 7, a worm 12 is provided in the head as shown in Fig. 2. Circular recess 6d is cut away at one side to form a substantially rectangular enlargement 6f of sufficient size to receive a worm 12 which meshes with worm gear 7. In one end of enlargement 6f is a bore 6g adapted to receive a bearing extension 12a on the inner end of worm 12. The opposite end of enlargement 6f is provided with a bore 6h aligned with bore 6g, said bore 6h being threaded and extending through the side of head 6. Bore 6h is of such diameter as to permit the worm 12 and its annular flange 12b to be passed through the bore 6h when assembling the parts. Threaded into bore 6h is a ring nut 13 having a bore 13a rotatably receiving an enlargement 12c on the outer end of worm 12 adjacent an annular flange 12b on the worm, the bore 13a of ring nut 13 forming a bearing for the outer end of the worm when the ring nut 13 is screwed into place in bore 6h with its inner end contacting the annular flange 12b of the worm. The enlarged end 12c of worm 12 is provided with a socket 12d of non-circular shape adapted to receive the correspondingly shaped end of an Allenhead wrench W shown in dot-and-dash lines in Fig. 2, whereby the worm 12 when thus mounted in the head may be rotated to rotate the worm gear 7 and the shaft 5.

In the lower end of head 6 is a threaded recess 6k for engagement with a pulling instrument when it is necessary or desired to withdraw the balancing unit from the tapered bore B' of the propeller shank B; and also in the lower end of head 6 are holes 6m for use in connection with a jig used to locate the axis of a bore B2, so that when the unit thus described has been inserted in the tapered bore B' of propeller shank B, the position of the transverse bore B2 through the side of the propeller shank B and through the adjacent wall of the shell 1 may be determined by the jig, the bore B2 being disposed in alignment with the bore of the ring nut 13 and worm 12, whereby an Allenhead or other wrench or tool may be entered through the bore B2 so that its non-circular end will engage the non-circular recess 12d in the end of worm 12, and whereby rotation of such wrench or tool will rotate the shaft 5 through the worm 12 and worm gear 7.

In use, one of my above described balancing units will be mounted in each propeller blade B on hub A, and the weights 5 of the various blades would initially be disposed substantially equi-distant from the ends of the shells 1. When balancing, an Allenhead wrench W may be inserted through a bore B2, and when turned the related worm 12 will rotate the related shaft 5 and cause the related weight 2 to be shifted axially of its shell sleeve 1, depending upon the direction of rotation of the wrench. The use of the worm 12 and worm gear 7 forms a positive lock for the shaft and consequently for the weight when the Allenhead wrench W is withdrawn, so that neither centrifugal force nor vibration can shift the weight 2 during flight, which shifting would throw the propeller and hub assembly out of balance.

In event a propeller blade should become damaged, its shank B may be removed from hub A and a suitable tool engaged with the threaded bore 6k of head 6; and a downward pull thereon will remove the entire balancing unit from the tapered bore B', whereupon the unit, if not damaged, may be transferred to an undamaged propeller; and thus the unit may be salvaged separately from the propeller rendering my balancing unit extremely practical. My novel unit is adaptable for use in any standard propeller now in use having a bore in its shank, said unit presenting no interference with the ordinary mounting of the propeller shank on the hub by the use of the sleeves C engaging hub extensions A', and said unit presenting no interference with the customary means for rotating the propeller on the hub to vary the pitch of the blade. The mounting of the unit does not require any weakening of the blade or the shank, since the bore B2 is merely of sufficient diameter to permit the small Allenhead wrench to have access to the non-circular bore in the end of the worm. The arrangement of the shaft and gearing in my unit forms a positive lock for the weight in the shell, whereby the shaft 5 will remain in any position to which it is adjusted by the Allenhead wrench.

My novel balancing unit may be manufactured

as a completely assembled unit far from the place where the blade is manufactured, and can be mounted in the blade by any mechanic supplied with a jig in five minutes or less, since all that has to be done to the propeller is the drilling of a $\frac{3}{16}$'' bore B2 through the propeller wall to take the $\frac{1}{8}$'' Allenhead wrench W, the location of the bore B2 being determined by the jig. The weight 2 which is threaded into the inner wall of the shell 1 exerts no strain on the shaft 5 due to centrifugal force; and the worm 12 which rotates shaft 5, and the worm gear 7 with which it meshes, forms a positive lock in any position, rendering it possible to make a most delicate adjustment when balancing.

I do not limit my invention to the exact form shown in the drawing, for obviously changes may be made therein within the scope of the claims.

I claim:

1. In combination, a propeller blade having a bore, a propeller hub having an extension entering the bore; a balancing unit removably mounted in said bore beyond the extension, said unit comprising a shell having an exterior corresponding with that of the bore, said shell having a threaded bore in one end, a threaded weight in the threaded bore, a head at the other end of the shell, a worm gear journaled in said head; a shaft rotated by said gear; said weight being rotatable with said shaft; a worm journaled in said head and meshing with said worm gear, said worm having a tool socket in one end exposed through an opening in the head; and said blade and shell having registering bores aligned with the worm socket opening permitting access of a worm rotating tool into said socket.

2. In a combination as set forth in claim 1, said shaft being non-circular and passing through a correspondingly shaped bore in said weight.

3. In a combination as set forth in claim 1, said head having a recess in its inner end; said worm gear being mounted on said shaft and being housed in said recess; a washer in said recess contacting the outer face of said worm gear, the thickness of said washer and gear filling the depth of said recess; and a cap covering the inner end of said head and closing said recess, said cap having an opening therein for the said shaft.

4. In a combination as set forth in claim 1, said head having a recess in which said worm gear is journaled; said recess having a lateral enlargement receiving said worm; a bearing for one end of said worm at one end of said enlargement; the opposite end of said enlargement having a threaded bore opposite the bearing and of sufficient diameter to permit passage of the worm therethrough; a ring nut in said threaded bore of the enlargement forming a bearing for the opposite end of the worm; an annular flange on the worm engaging the inner end of the ring nut, and said tool socket being provided in the end of the worm journaled in the ring nut and being accessible through the ring nut.

5. In a combination as set forth in claim 1, said head having a threaded bore in its outer end adapted to receive an extracting tool whereby the unit may be withdrawn from the bore of the blade.

6. In a combination as set forth in claim 1, said head having jig locating holes in its outer end for locating the registering bores in the blade and shell which align with the socket in the end of the worm.

7. In combination, a propeller blade having a tapered bore; a hub having an extension entering the bore permitting rotation of the blade on the hub; a balancing unit removably mounted in said bore beyond the extension, said unit comprising a shell having a tapered exterior corresponding with that of the bore, said shell having a threaded bore in its smaller end, a threaded weight in the threaded bore, a head at the larger end of the shell, a worm gear journaled in said head; a shaft fixedly mounted in said gear and extending through a bore in said weight; said weight being rotatable with said shaft; a worm journaled in said head and meshing with said worm gear, said worm having a tool socket in one end exposed through an opening in the side of the head; and said blade and shell having registering bores aligned with the worm socket opening adapted to receive a worm rotating tool.

8. In a combination as set forth in claim 7, said shaft being non-circular; and said weight rotating means comprising plates secured to the ends of the weight having corresponding non-circular holes receiving the said shaft.

9. In a combination as set forth in claim 7, said head having a recess in its inner end; said worm gear being mounted on said shaft and being housed in said recess; a washer in said recess contacting the outer face of said worm gear, the thickness of said washer and gear filling the depth of said recess; and a cap covering the inner end of said head and closing said recess; said cap having an opening therein for the said shaft.

10. In a combination as set forth in claim 7, said threaded bore communicating with an enlarged threaded bore at the larger end of the shell; and said head comprising a threaded block in said enlarged threaded bore, said block having a circular recess in its inner end provided with an axially disposed seat for the end of said shaft; said worm gear being housed in said recess; washers in said recess contacting one or both faces of said gear, the thickness of said washers and gear filling the depth of said recess; a cap on the inner face of the head contacting the inner end of the enlarged bore and having exterior threads engaging the threads of the enlarged bore; means for rotating the cap with said head; and said cap having a central opening therein for the said shaft.

11. In a combination as set forth in claim 7, said head having a recess in which said worm gear is journaled; said recess having a lateral enlargement receiving said worm; a bearing for one end of said worm at one end of said enlargement; the opposite end of said enlargement having a threaded bore opposite the bearing and of sufficient diameter to permit passage of the worm therethrough; a ring nut in said threaded bore of the enlargement forming a bearing for the opposite end of the worm; an annular flange on the worm engaging the inner end of the ring nut, and said tool socket being provided in the end of the worm journaled in the ring nut and being accessible through the ring nut.

12. In a combination as set forth in claim 7, said threaded bore communicating with an enlarged threaded bore at the larger end of the shell; and said head comprising a threaded block in said enlarged threaded bore, said block having a recess in which said worm gear is journaled; said recess having a lateral enlargement receiving said worm; a bore at one end of said lateral enlargement receiving a bearing extension of said worm; the opposite end of said lateral enlargement having a threaded bore opposite the first named bore and of a sufficient diam-

eter to permit passage of the worm therethrough, a ring nut in said threaded bore of the enlargement forming a bearing for the opposite end of the worm; an annular flange on the worm engaging the inner end of the ring nut, and said tool socket being provided in the end of the worm journaled in the ring nut and being accessible through the ring nut.

13. A removable balancing unit adapted to be inserted in the bore of the shank of a propeller blade, comprising a shell having an exterior corresponding with that of the bore, said shell having a threaded bore in one end, a threaded weight in the threaded bore, a head at the other end of the shell, a worm gear journaled in said head; a shaft rotated by said gear; means for rotating the weight with said shaft; a worm journaled in said head and meshing with said worm gear; and said worm having a tool socket in one end exposed through an opening in the side of the head.

14. In a combination as set forth in claim 13, said shaft extending through a bore in said weight, and being non-circular; and said weight rotating means comprising plates secured to the ends of the weight having corresponding non-circular holes receiving the said shaft.

15. In a unit as set forth in claim 13, said head having a circular recess in its inner end; said worm gear being mounted on said shaft and being housed in said recess; washers in said recess contacting one or both faces of said gear, the thickness of said washers and gear filling the depth of said recess; and a cap covering the inner face of the head and closing the recess, and said cap having a central opening therein for the said shaft.

16. In a unit as set forth in claim 13, said threaded bore connecting with an enlarged threaded bore at the other end of the shell; and said head comprising a threaded block in said enlarged threaded bore, said block having a recess in its inner end provided with an axially disposed seat for the end of said shaft; said worm gear being mounted on said shaft and being housed in said recess; washers in said recess contacting one or both faces of said gear, the thickness of said washers and gear filling the depth of said recess; a cap on the inner face of the head contacting the inner end of the enlarged bore and having exterior threads engaging the threads of the enlarged bore; means for rotating the cap with said head; and said cap having a central opening therein for the said shaft.

17. In a unit as set forth in claim 13, said head having a recess in which said worm gear is journaled; said recess having a lateral enlargement receiving said worm; a bearing for one end of said worm at one end of said enlargement; the opposite end of said enlargement having a threaded bore opposite the bearing and of sufficient diameter to permit passage of the worm therethrough; a ring nut in said threaded bore of the enlargement forming a bearing for the opposite end of the worm; an annular flange on the worm engaging the inner end of the ring nut, and said tool socket being provided in the end of the worm journaled in the ring nut and being accessible through the ring nut.

18. In a unit as set forth in claim 13, said threaded bore communicating with an enlarged threaded bore at the larger end of the shell; and said head comprising a threaded block in said enlarged threaded bore, said block having a recess in which said worm gear is journaled; said recess having a lateral enlargement receiving said worm; a bore at one end of said enlargement receiving a bearing extension of said worm; the opposite end of said enlargement having a threaded bore opposite the first named bore and of sufficient diameter to permit passage of the worm therethrough; a ring nut in said threaded bore of the enlargement forming a bearing for the opposite end of the worm; an annular flange on the worm engaging the inner end of the ring nut, and said tool socket being provided in the end of the worm journaled in the ring nut and being accessible through the ring nut.

19. A removable balancing unit adapted to be inserted in the tapered bore of the shank of a propeller blade, comprising a shell having a tapered exterior corresponding with that of the tapered bore, and having a threaded bore in its smaller end, a threaded weight in the threaded bore, said threaded bore communicating with an enlarged threaded bore at the larger end of the shell; a threaded block in the enlarged threaded bore of the shell, said block having a recess in its inner end, a worm gear journaled in said recess; a shaft fixedly mounted in said gear and extending through a bore in said weight; means for rotating the weight with said shaft; a worm journaled in said recess and meshing with said worm gear, and said worm having a tool socket in one end exposed through an opening in the side of the shell.

20. In a unit as set forth in claim 19, a bearing for one end of said worm at one side of said recess; the opposite side of said recess having a threaded bore of a diameter sufficient to permit passage of the worm therethrough; a ring nut in said threaded bore of the recess forming a bearing for the opposite end of the worm; an annular flange on the worm engaging the inner end of the ring nut, and said tool socket being provided in the end of the worm journaled in the ring nut and being accessible through the ring nut.

21. A self-contained unit comprising a shell adapted to be mounted in the bore of the shank of a propeller blade carried by a hub, a weight mounted in the said shell, and means for shifting said weight within the shell without removing the propeller blade from the hub.

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