Aug. 8, 1933. P. J. P. RATIER 1,921,942

METALLIC PROPELLER

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Fig:5

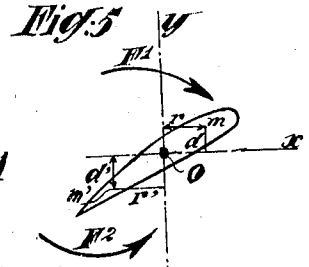
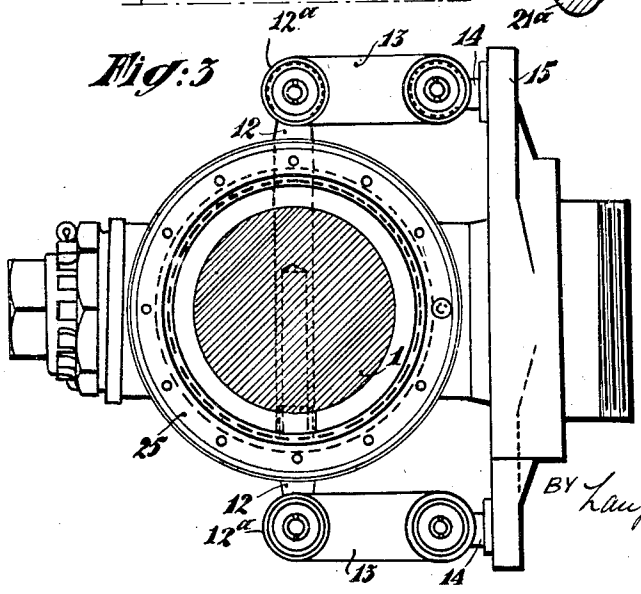


Fig:1

Fig:3



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Fig. 2

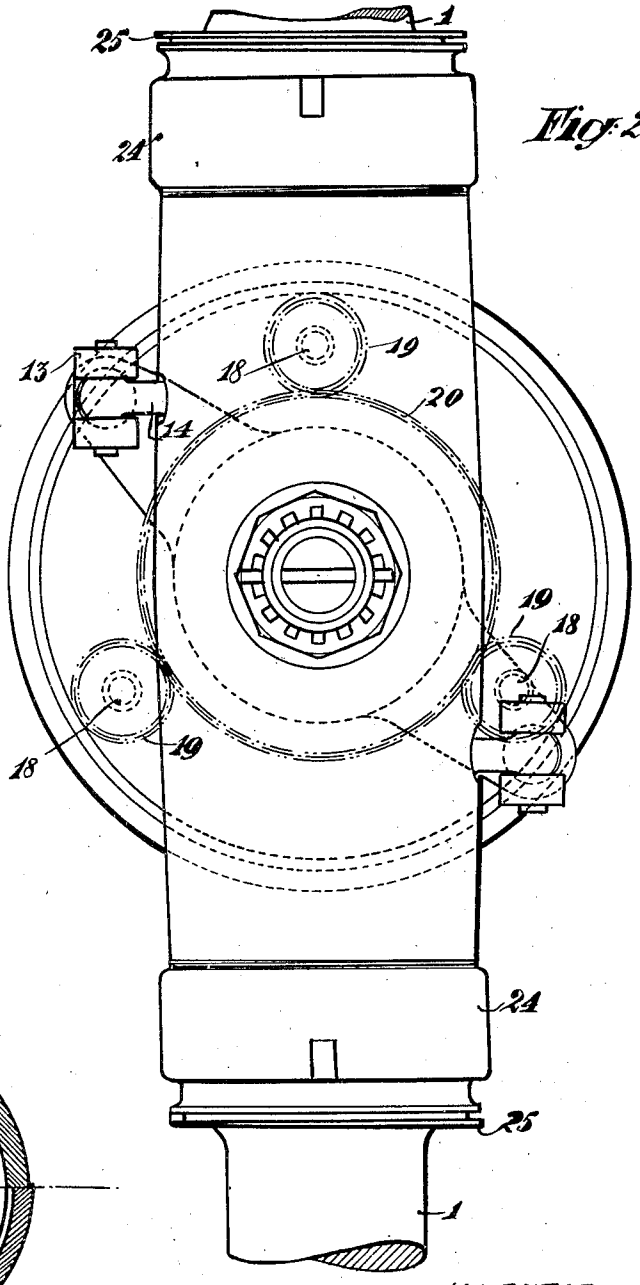
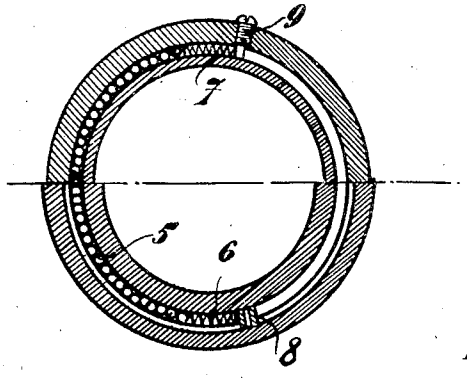


Fig. 1



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UNITED STATES PATENT OFFICE

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METALLIC PROPELLER

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Application March 15, 1929, Serial No. 347,405, and in France October 31, 1928

7 Claims. (Cl. 170—163)

For varying the incidence of the blades of a propeller in flight and at the normal range of the motor, it is first necessary to overcome the frictional resistances due on the one hand to centrifugal forces and on the other hand the flexion forces concentrated in the attaching device on the hub.

On the other hand, there exists a torsion couple due to centrifugal forces which tend to orientate the blades in the direction of their largest moment of inertia with respect to the axis of rotation.

This couple can become annulled by judiciously disposing the center of gravity of each section, but another disadvantage presents itself; the neutral fibre which passes through the center of gravity of all the sections does not respond any more to the law of flexion stresses, and the rate of work becomes increased in such a way that no way has been thought of for annulling or destroying in part this couple of torsion.

In order to overcome these disadvantages I have invented a metallic propeller whose pitch may be varied during flight, which is the object of the present invention, in which the novelty resides in the connection between each foot of a blade and its hub being assured by threads with a certain play existing between them or free space in which are engaged balls. By means of this arrangement, the blade foot and the hub are connected in a way by a ball bearing of a helicoidal form having a low pitch and extending over a certain length of the blade foot. Under these conditions, not only the orientation control of the blades is rendered very easy, but also the couple of torsion due to the centrifugal forces is annulled by the opposing couple which the said centrifugal force produces on the helicoidal threads.

The said control of the orientation of the blades may be realized by means of a sleeve sliding along the lining of the hub keyed to the driving arbor of the propeller, which sleeve is connected by small connecting rods and by spindles forming levers to the blade feet.

The invention will be more readily understood in the following description, when taken in connection with the accompanying drawings forming part of this specification, and in which—

Fig. 1 is a longitudinal section through a propeller constructed in accordance with my invention;

Fig. 2 is a front view thereof;

Fig. 3 is a plan view with parts in section;

Fig. 4 is a broken section partly on the line A—A and partly on the line B—B of Fig. 1; and

Fig. 5 is a diagram showing how balancing of the blade takes place for a given incidence.

Referring to the drawings more in detail, the metallic blade 1 of the propeller is mounted in the blade foot 3 and locked by means of a nut 4, the blade and the blade foot being in addition connected together by a haft and key arrangement 4^a. On the blade foot 3 is provided a set of threads 3^a of low pitch which engage a set of threads 2^a provided in the hub 2, the said sets of threads being arranged in a way that play or free space exists between them forming thus a race or helicoidal incline. In said free space, are engaged the balls 5 which constitute a ball bearing or abutment of helicoidal form interposed between the blade foot and the hub and which extends over nearly the whole length of the blade foot. The balls 5 are retained between stop springs 6 at the top and stop springs 7 at the bottom, the first bearing against a key 8 and the second against a screw 9 (Fig. 4).

At the base of the foot 1 is disposed a ball bearing 11 surrounding a boss 11^a of hub 2, which assures centering and guiding of the blade when the pitch thereof is varied, as well as absorption of the vibrations of the foot of the blade while running.

Finally, the hub 2 is provided at its extremity with a thread on which is fixed a nut 24 for taking up play provided at 24^a with a tapered part coming into contact with a similar tapered extremity of the hub which is provided with four saw cuts 24^b, all of which allows by screwing the nut 24 to tighten or apply the extremity of the hub on the balls. A packing nut 25 terminates the arrangement and prevents leaks of grease or oil in which the balls 5 are submerged.

Variation of the pitch of the propeller during flight takes place in the following manner:

In each blade foot is engaged a lever 12 terminating in an eyelet 12^a to which is pivoted the link 13 pivoted itself at the other end to a shaft 14 rigid with a sleeve 15. The latter is adapted to slide longitudinally along the lining 10 of the hub which is keyed on the driving arbor 10^a. The longitudinal displacement of the sleeve is obtained by a slide block 17 in which are screwed the threaded extremities of three rods 18, forming jacks, and of which one is driven directly by the shaft 18^a and the others by the control pinions 19 meshing with the intermediary toothed wheel 20.

The connection between the slide block 17 and the sleeve 15 is assured by a ball bearing

16 sufficiently rigid to also constitute an abutment.

A ball bearing 23 also rigid is interposed between the lining of the hub 10 and the casing 21 on the interior of which are mounted the arbors, pinions and control wheels, which is closed by a cover 22 and the tightness of the casing, which is filled with oil or grease, is assured by joints 21^a, 22^a.

From the foregoing it will be obvious that for varying the pitch of the propeller when in flight, the pilot has but to turn, by a suitable remote control device, the shaft 18^a, which determines the longitudinal displacement of the slide-block 17, which drives with it through the medium of the ball bearing 16, the sleeve 15 and displaces the balls 13 and the levers 12 in a way that the two blade feet each turn in the hub in opposite directions with respect to each other while bearing on the balls 5.

The angular displacement of the blade foot in the hub is rather small in order that the axial displacement resulting from the presence of the thread of the blade foot be practically zero.

Obviously my improved propeller not only allows very easily actuating the orientation control of the blades, but also to annul the torsion couple due to the centrifugal forces by the opposing couple that the centrifugal force produces on the helicoidal thread, as shown by the diagram in Fig. 5. In this figure F^1 represents the direction of the torsion couple and F^2 the direction of the opposing couple. O represents the pivotal axis of the blade, y y' the axis of rotation of the motor, d r and d' r' the coordinates of two points of mass m m' with respect to $o\,x$, $o\,y$.

The balancing of the torsion couple, by the centrifugal forces is established as follows:

Assuming that the direction of the thread is to the right for a propeller with a right hand pitch and to the left for a propeller with a left hand pitch, then

$$H=\frac{C_t 2\pi}{F}$$

wherein: F=The centrifugal forces of a blade; C_t=The couple of torsion; and H=The pitch of the thread.

If we consider the molecules of the masses m and m' in one of the sections of the blade, we then obtain as a partial torsion couple:

$$C_t=(mdr+m'd'r').w^2,$$

and the total torsion couple becomes:

$$C_t=\int_o^R Sdrx\frac{d}{g}w^2$$

wherein: d=The density of the metal employed, and w=The angular speed of the propeller.

While I have disclosed what I deem to be the preferred form of my device, I do not wish to be limited thereto as there might be many modifications made there by those skilled in the art without departing from the spirit of my invention as comprehended within the scope of the appended claims.

In particular, in certain cases I may replace the balls 5 by rollers.

Having described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a variable pitch propeller, a hub having internally threaded bores, blades having a screw-threaded root for fitting with play in the bores of the hub, the direction of the screw-thread and its inclination being so chosen as to give rise on the blades, under the action of the radial component of the centrifugal force, to a torque balancing the torsion torque due to the same centrifugal force, balls interposed in the clearance provided between the screw-thread of the blade roots and the inner screw-thread of the hub, and means for causing the blades to pivot on their axis during the rotation of the propeller.

2. In a variable pitch propeller, a hub having internally threaded bores, blades having a screw-threaded root for fitting with play in the bores of the hub, the direction of the screw-thread and its inclination being so chosen as to give rise, on the blades, under the action of the radial component of the centrifugal force, to a torque balancing the torsion torque due to the same centrifugal force, balls interposed in the clearance provided between the screw-thread of the blade roots and the inner screw-thread of the hub, at least one spring pressing these balls against each other, and means for causing the blades to pivot on their axis during the rotation of the propeller.

3. In a variable pitch propeller, a hub having internally threaded bores, blades having a screw-threaded root for fitting with play in the bores of the hub, the direction of the screw-thread and its inclination being so chosen as to give rise, on the blades, under the action of the radial component of the centrifugal force, to a torque balancing the torsion torque due to the same centrifugal force, balls interposed in the clearance provided between the screw-thread of the blade roots and the inner screw-thread of the hub, at least one spring pressing these balls against each other, means for radial guiding between the hub and the blades, and means for causing the blades to pivot on their axis during the rotation of the propeller.

4. In a variable pitch propeller, a hub having internally threaded bores, blades having a screw-threaded root for fitting with play in the bores of the hub, the direction of the screw-thread and its inclination being so chosen as to give rise, on the blades, under the action of the radial component of the centrifugal force, to a torque balancing the torsion torque due to the same centrifugal force, balls interposed in the clearance provided between the screw-thread of the blade roots and the inner screw-thread of the hub, at least one spring pressing these balls against each other, a boss provided, on the hub, in the axis of each bore and so arranged as to be surrounded by a corresponding hole of the blade root, in order to guide the same and means for causing the blades to pivot on their axis during the rotation of the propeller.

5. In a variable pitch propeller, a hub having internally threaded bores, blades having a screw-threaded root for fitting with play in the bores of the hub, the direction of the screw-thread and its inclination being so chosen as to give rise, on the blades, under the action of the radial component of the centrifugal force, to a torque balancing the torsion torque due to the same centrifugal force, balls interposed in the clearance provided between the screw-thread of the blade roots and the inner screw-thread of the hub, at least one spring pressing these balls against each other, a boss provided, on the hub, in the axis of each bore and receiving a ball bearing so arranged as to be surrounded by a corresponding hole of the blade root, in order to guide the same and means

for causing the blades to pivot on their axis during the rotation of the propeller.

6. In a variable pitch propeller, a hub having internally threaded bores, blades having a screw-threaded root for fitting with play in the bores of the hub, balls interposed in the said play, and means for causing the blades to pivot on their axes during the rotation of the propeller.

7. A variable pitch propeller comprising in combination a member secured to the driving shaft, a blade rotatably and axially movable on said member, a ball bearing with helical race for connecting said member with said blade whereby centrifugal force acting on said blade causes helical motion of the latter and yielding means for opposing the rotary component of said helical motion.

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