

May 10, 1938.

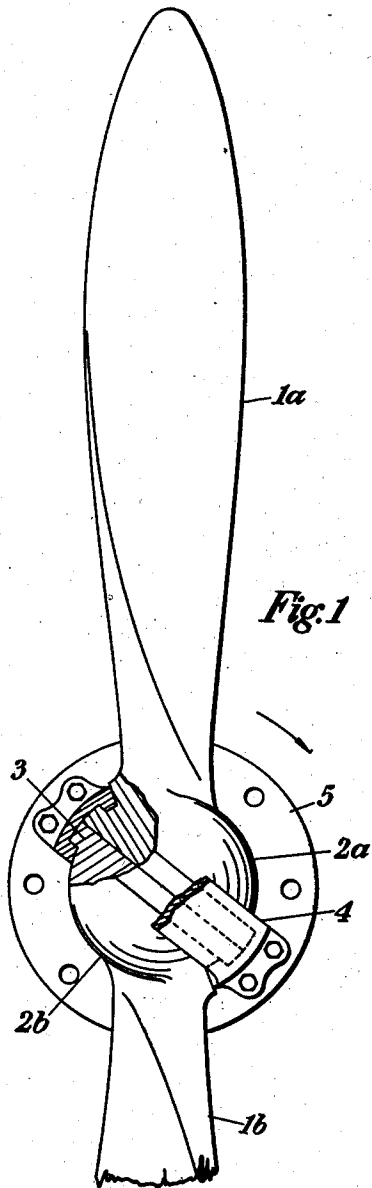
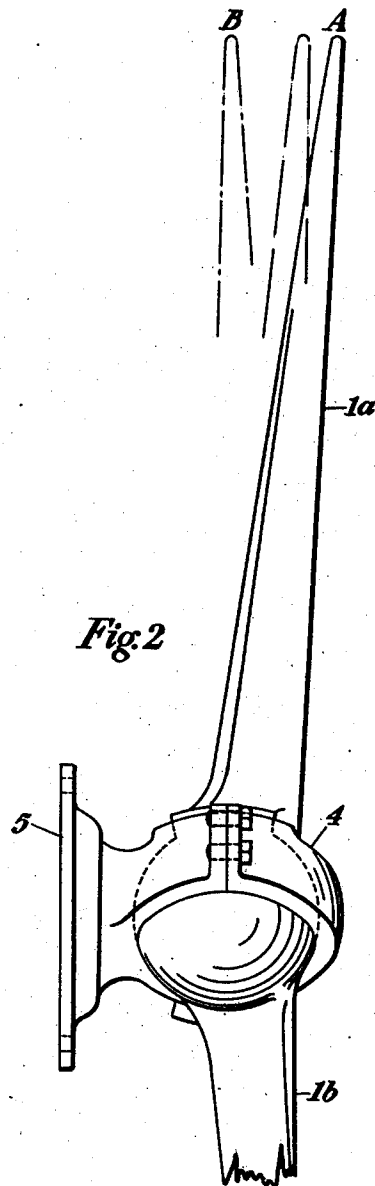
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2,117,062

VARIABLE PITCH PROPELLER

Filed Oct. 3, 1935

3 Sheets-Sheet 1



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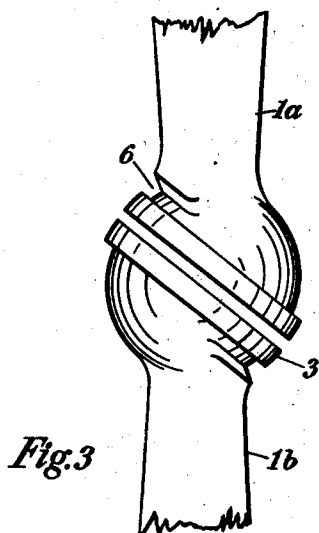
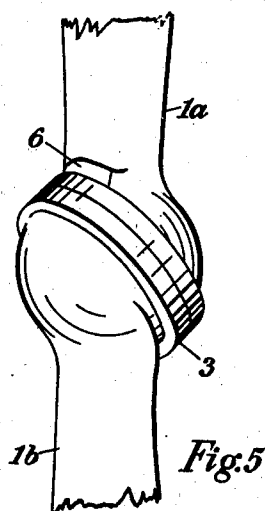
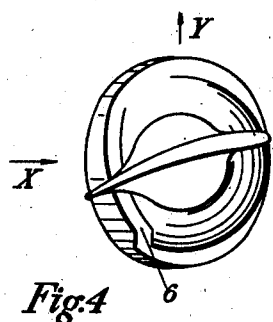
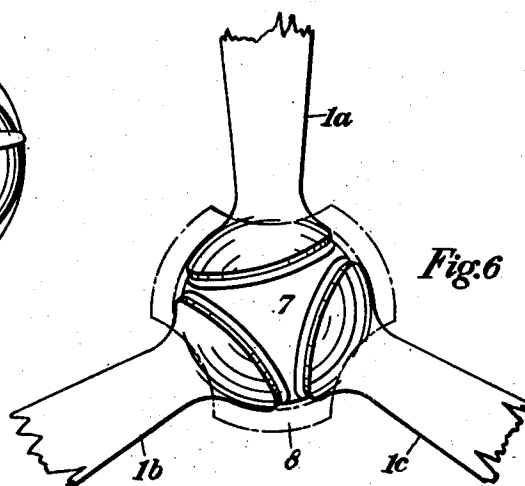
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VARIABLE PITCH PROPELLER

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3 Sheets-Sheet 2



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VARIABLE PITCH PROPELLER

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3 Sheets-Sheet 3

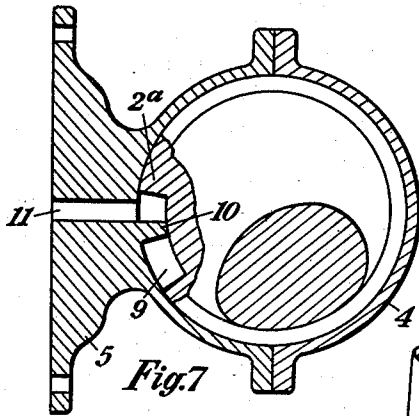


Fig. 7

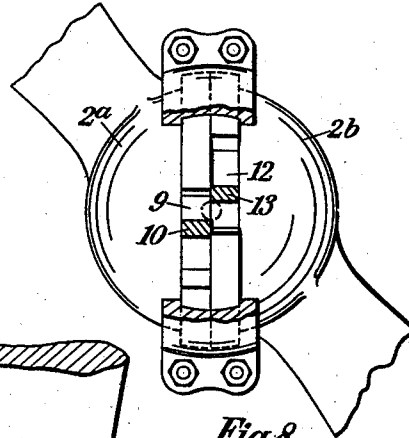


Fig. 8

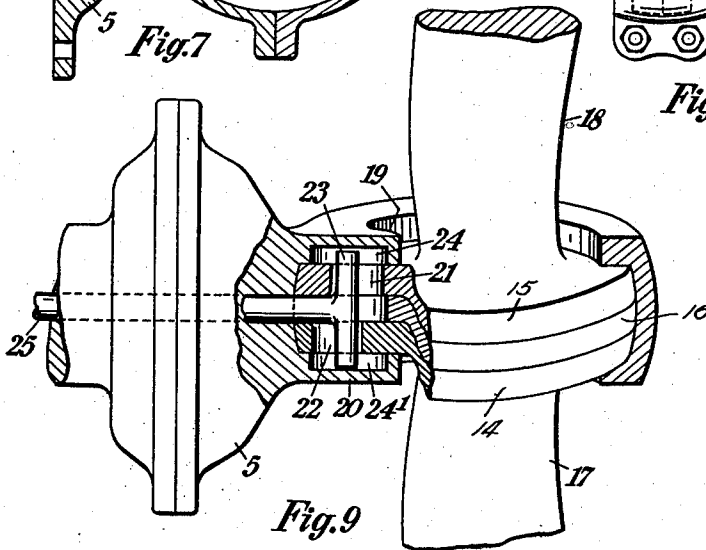


Fig. 9

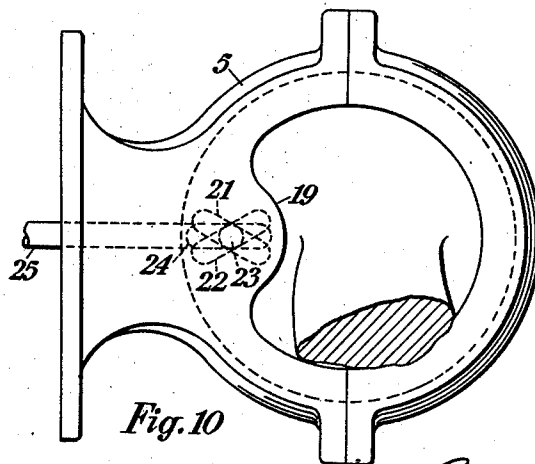


Fig. 10

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UNITED STATES PATENT OFFICE

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VARIABLE PITCH PROPELLER

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Application October 3, 1935, Serial No. 43,419
In Great Britain February 6, 1935

5 Claims. (Cl. 170-164)

The present invention relates to propellers and more particularly to propellers of variable pitch.

It is an object of the present invention to provide a variable pitch propeller adapted to be set automatically to an appropriate pitch by and in accordance with the natural forces acting thereon.

It is a further object of the invention to provide a propeller of variable pitch comprising a hub in which the blades are mounted so as to be freely movable under the influence of the natural forces acting thereon, their movements being correlated so as to produce a pitch of appropriate value determined by said natural forces.

It is a further object of the invention to provide a variable pitch propeller comprising means for setting the propeller blades to the desired pitch in accordance with the natural forces acting thereon without substantially increasing the weight of the propeller and its associated mechanism above the weight of an ordinary propeller.

The forces acting on the blades of the propeller are chiefly centrifugal force due to the rotation of the propeller, which acts longitudinally of the blades, the thrust which acts on the rear surfaces of the blades and constitutes the tractive power of the propeller and the torsion in the blades which tends to turn the blades into the position of minimum pitch. All these forces vary in proportion to the speed of the craft, the speed of the engine acting on the propeller and flying conditions generally and it is therefore desired to set the pitch of propeller in accordance with such forces. It is furthermore desired to employ these forces themselves to effect the necessary movement of the propeller blades.

It is also an object of the invention to provide manually controlled means whereby the pitch of propeller may be controlled independently of, or in addition to the control effected by said natural forces.

In order that the invention may be more clearly understood some embodiments thereof will now be described with reference to the accompanying drawings wherein:

Fig. 1 is a front view of a propeller and its mounting.

Fig. 2 is a side elevation of the propeller shown in Fig. 1.

Fig. 3 shows the roots of the propeller blades with the collar of the hub removed, and the two hemispheres separated slightly.

Fig. 4 is a plan view of one blade.

Fig. 5 is a view similar to that of Fig. 3 of a pair of blades in which the common surface of

abutment is disposed obliquely in more than one sense.

Fig. 6 is a modification of the invention applied to a three-bladed propeller.

Fig. 7 is a longitudinal section and

Fig. 8 is a partial transverse section of a hub construction embodying hydraulic means for controlling the movements of the blades.

Fig. 9 is an elevation, partly in section and

Fig. 10 a plan of a mechanical arrangement for controlling the movements of the blades.

Referring to the drawings the propeller shown in Figs. 1 to 4 comprises two blades 1a, 1b mounted on or ending in roots 2a and 2b respectively which may be made of different material from the rest of the blade, and attached thereto, or may be formed in one piece with the respective blades. As will be seen from Figs. 2 and 3 these roots are in this example hemispherical in form and have abutting bearing surfaces set obliquely to the longitudinal axes of the propeller blades. Each bearing surface constitutes a complementary bearing surface to the other. Each root comprises a flange 3 and the two blades are held together by means of a collar 4 which embraces the two flanges. The collar 4 is shown built up of two parts bolted together and is carried by a base plate 5 for attachment to the shaft of the engine. It will thus be seen that each blade is rotatable upon the plane of abutment of the roots, the movement of each blade being a combination of a forward movement and a rotational movement about the longitudinal axis of the blade.

The movement of the blades due to torsion may be controlled by means of a cam groove 6, the disposition of which may be clearly seen from the plan view of Fig. 4. The cam 6 also serves to control the application of power from the engine to the propeller, providing for a degree of lost motion between the propeller shaft and the blades. This may be employed to impart an additional controlling movement to the propeller blades to ensure that the pitch will be at a minimum when the engine has to exert additional power, owing to increased thrust or vice versa.

The action of the construction according to the invention is as follows:

As the propeller rotates, the centrifugal forces acting on the propeller blades tend to maintain the blades in one plane i. e. the plane of rotation (position B in Fig. 2). However, when the aircraft is taking off or performing some other manoeuvre which calls for greater tractional power to be exerted by the propeller an increased

thrust on the propeller is developed which urges the propeller blades forward towards the position A shown in Fig. 2. In this position the blades form a shallow V. In this position the propeller blades present the least pitch.

As the craft gathers speed and attains to its normal cruising speed, or as the manoeuvre calling for an exertion of power by the propeller is completed, the thrust on the propeller blades is relieved and the centrifugal forces progressively take effect to return the propeller blades towards the co-planar relation. As they undergo this movement, the oblique plane of contact between the inner ends of the roots of the propeller blades forces the blades to rotate about their individual longitudinal axes, the pitch of the propeller thus being increased to a suitable value for the flying conditions now to be maintained. If a climb is to be made, the consequent increased thrust on the rear (inner) surface of the propeller blades again takes effect against the centrifugal force which is overcome by the increased thrust and further reduced due to the reduction in speed or revolution of the propeller and moves the blades forward, thus effecting rotation thereof into a position of decreased pitch.

In order to ease the movement of the blades, means may be provided for reducing friction arising between the abutting surfaces of the roots and/or between the roots and the collar, for instance such as ball bearings or roller bearings, in these surfaces.

Fig. 5 shows a pair of hemispherical blade roots which are mounted in abutting relation, the plane of abutment being oblique to the axis of symmetry of said blades and also of the propeller shaft.

The invention is also applicable to propellers having more than two blades and an example of construction applied to a three-bladed propeller is shown in Fig. 6. In this construction the three blades 1a, 1b and 1c each terminate in part-spherical roots 2a, 2b, 2c which abut respectively on complementary bearing surfaces provided on a common bearing member 7. The three bearing surfaces of the member 7 are each disposed obliquely to the longitudinal axis of the corresponding blade.

The blade roots together with the common bearing member form a complete sphere and the whole is held together by means of a casing or cage 8.

The operation of this arrangement is precisely similar to the operation of the construction described with reference to Figs. 1 to 4 and need not be further described here.

Referring now to the construction shown in Figs. 7 and 8 the blade root 2a is provided with a chamber 9 which is bounded by two radial surfaces and an inner curved surface concentric with the circumference of the blade root. On the hub portion 5 there is provided a projection 10 which projects into the chamber 9 so dividing the latter into two parts and seals the lower part against ingress of fluid from the upper part. The upper part communicates with a conduit 11 which passes through the hub portion 5 and connects with a conduit provided in the propeller shaft. Similarly, in the root 2b a cavity 12 is provided into which projects a projection 13 provided on the hub portion 5. The conduit 11, however, communicates with the lower part of the chamber 12.

The operation of this construction is as follows: Oil or other suitable liquid is introduced

under pressure through the conduit 11 to the upper part of the chamber 9 and the lower part of the chamber 12. The pressure of the oil or other fluid tends to expand the parts of the chambers 9 and 12 which it fills, and thus imparts opposite turning forces to the two roots. Thus the root 2a shown in Fig. 7 is turned in the clockwise direction while the root 2b is urged in the anti-clockwise direction. The extent of movement of the two roots is limited by the trailing end of the respective chambers contacting with the corresponding projection 10 or 13.

The lower part of the chamber 9 and the upper part of the chamber 12 may be closed so that the air in said chambers is compressed during movement of the blade roots, whereby an air spring effect is provided tending to oppose the movements of the blades and return same to the normal position when the oil pressure is relieved.

Another arrangement according to the invention for varying the pitch of the propeller by means under the control of the pilot or automatically is shown in Figs. 9 and 10. In this embodiment the blade roots 14 and 15 are disc-shaped and are separated by a common bearing disc 16 having bearing surfaces complementary to those on the blade roots. The blades 17 and 18 are cut back to allow encroachments 19 and 20 provided on the hub portion 5 to project over the rear parts of the blade roots.

The blade roots are provided respectively with slots 21 and 22 which are oppositely inclined to the propeller axis. Sliding in the slots 21 and 22 is a cross pin 23 the ends of which project into slots or grooves 24 and 24' provided in the hub portion 5 and which extend parallel to the propeller shaft.

It will be apparent that this pin and slot arrangement provides a mechanical linkage between the blade roots which constrains them to move concurrently and ensures that the blades execute corresponding and correlated movements.

It will also be apparent that to-and-fro movement of the pin 23 up and down the slots 24 and 24' will cause turning movements of the propeller blades in opposite direction to increase or decrease the pitch according to the direction of movement of the pin 23.

In order that the pitch of the propeller may be controlled independently of the natural forces acting thereon, means are provided for moving the pin 23 back and forth in the grooves 24 and 24'. The means shown comprise a rod 25 which passes through a slot provided in the edge of the common bearing member 16, the propeller hub and the propeller shaft. At its other end the rod 25 is coupled by any suitable means to a control device operated by the pilot to move same backwards and forwards and so vary the pitch of the propeller. For instance the rod may be coupled to a Bowden cable which leads to a suitable control device to which the pilot has access.

The arrangements employed are designed to allow of free movement of the blades under the action of natural forces without manual control being brought into operation. The manual control will then be employed to control the pitch either in a sense which aids the action of the natural forces operating on the propeller or in the contrary sense according to whether an increased or decreased pitch variation is required.

The arrangements according to the invention which provide for control of the propeller pitch by manual or mechanical means acting in con-

junction with the natural forces possess a number of advantages. In the first place, since the natural forces always tend to adjust the propeller to the correct pitch, the manual or mechanical control is required only to augment or diminish the controlling effort of the natural forces. Consequently comparatively small forces are required to be exerted by the mechanical arrangement. On the other hand it is possible by the means described, to lock the pitch varying mechanism in the position corresponding to a predetermined pitch value, or to limit the extent of the pitch variation. It is also possible, if desired to anticipate pitch variations which will become necessary due to an intended manoeuvre and so ensure that sufficient engine speed or a sufficiently increased pitch is available for the execution of the manoeuvre before the response of the propeller to the changes in the natural forces acting thereon due to the said manoeuvre.

A number of embodiments and examples of methods of execution of the invention have been shown. It will be appreciated, however, that the invention is capable of execution in a large number of different ways in addition to those, examples of which have been given.

I claim:—

1. Variable pitch propeller, comprising a plurality of blades, a root member upon each of said blades, each of said root members being in the form of a disc having a plane surface disposed obliquely to the longitudinal axis of the respective blade, a common bearing disc between said root members and having plane surfaces respectively adjacent said plane surfaces of said roots, a collar embracing all said root members and said disc and holding the plane surfaces of said root members in abutting engagement with the respective plane surfaces of said disc, mutually inclined slots in said root discs, parallel grooves in said collar, a slot in said spacing disc parallel with said grooves, a transverse pin extending through said slots and engaging at its ends in said collar grooves, and means for moving said pin in the path defined by the grooves in said collar, to impart turning forces to said root members.

2. In a variable pitch propeller, a hub, a plurality of blades, a root member on each of said blades and rotatably mounted within said hub, a bearing surface on said root member directed inwardly towards the axis of said hub and oblique

to the longitudinal axis of said blades, a common bearing member interposed between said root members, having complementary bearing surfaces to those of said roots, means for holding said roots together in said hub with their bearing surfaces in engagement with the respective complementary bearing surfaces of said bearing member, and means operatively connecting said roots so as to constrain them to rotate concurrently, the arrangement being such that the pitch of said propeller is caused to vary automatically by and in accordance with the natural forces acting upon said blades.

3. In a variable pitch propeller, a hub, a plurality of blades, a root member on each of said blades and rotatably mounted within said hub, a bearing surface on said root member directed inwardly towards the axis of said hub and oblique to the longitudinal axis of said blade, a common bearing member interposed between said root members, having complementary bearing surfaces to those of said roots, means for holding said roots together in said hub with their bearing surfaces in engagement with the respective complementary bearing surfaces of said bearing member, means operatively connecting said roots so as to constrain them to rotate concurrently, and means for manually controlling said constraining means, such that the pitch of said propeller may be caused as desired to vary either wholly automatically by and in accordance with the natural forces acting upon said blades, or wholly or partially under the influence of said manual control means.

4. In a variable pitch propeller, a plurality of propeller blades each rotatable on an axis obliquely of the longitudinal axis of the blade to vary its pitch, the longitudinal axes of the blades passing substantially through the axis of rotation of the propeller in all positions of the blades.

5. In a variable pitch propeller, a hub, a plurality of blades, means for pivotally mounting each of said blades in said hub on an axis obliquely of the longitudinal axis of the blade to vary its pitch, said means including a bearing member common to the said blades and located within said hub between the root ends of said blades, the longitudinal axes of the blades each passing substantially through the axis of rotation of the propeller in all positions of the blades.

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