

March 19, 1946.

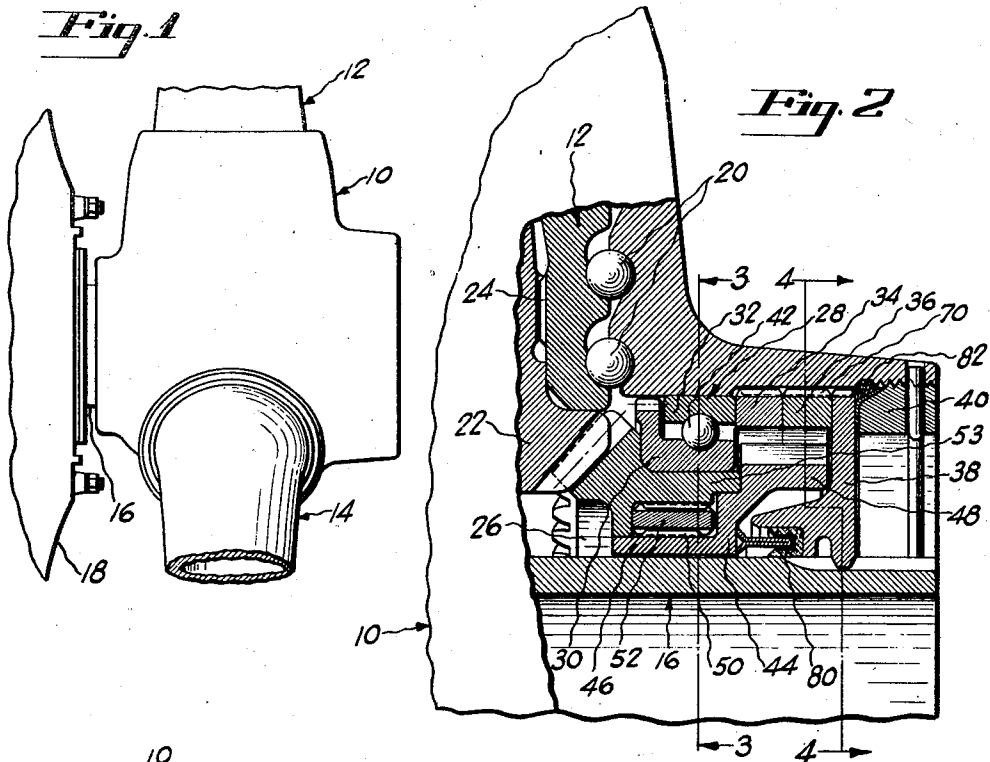
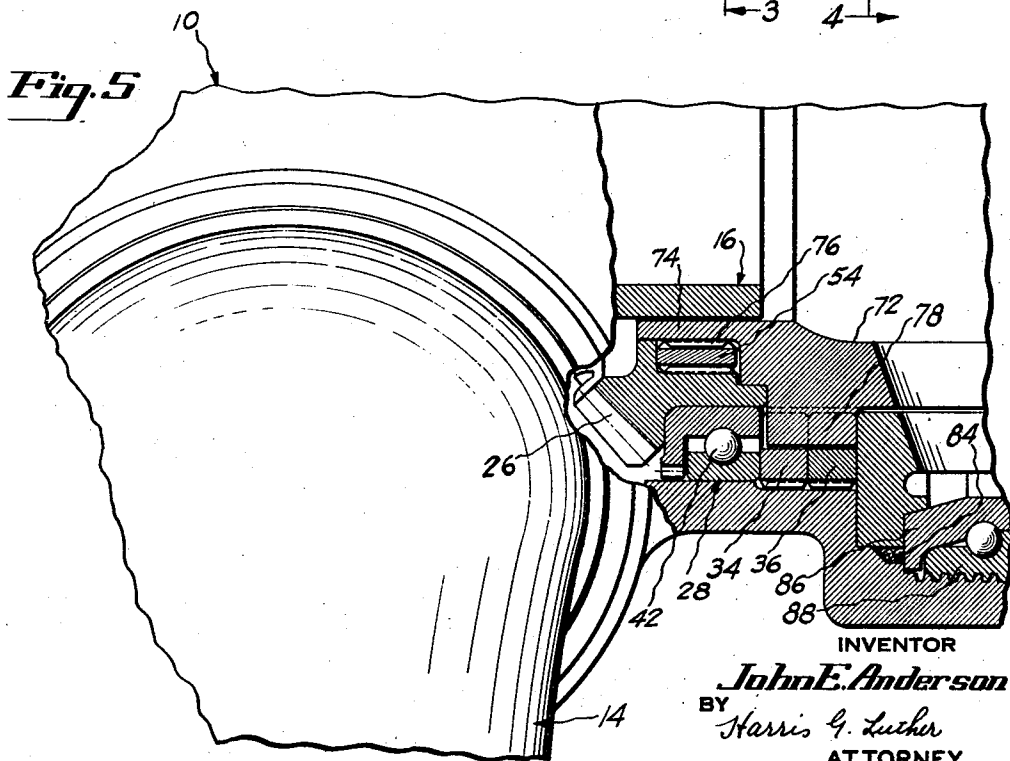
J. E. ANDERSON

2,396,630

BLADE ADJUSTING MEANS

Filed Oct. 17, 1940

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Fig. 3

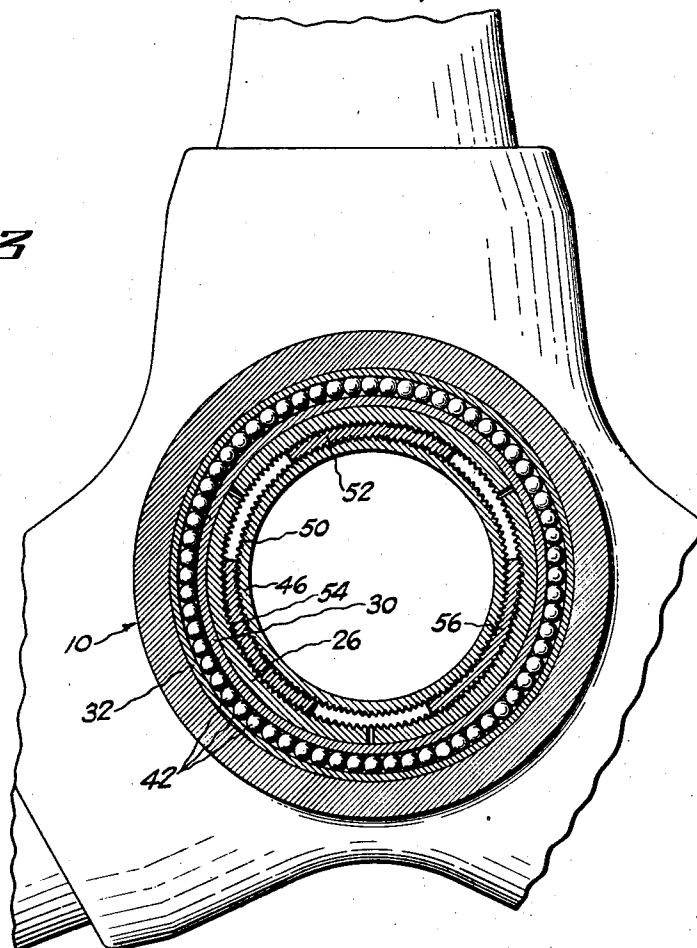
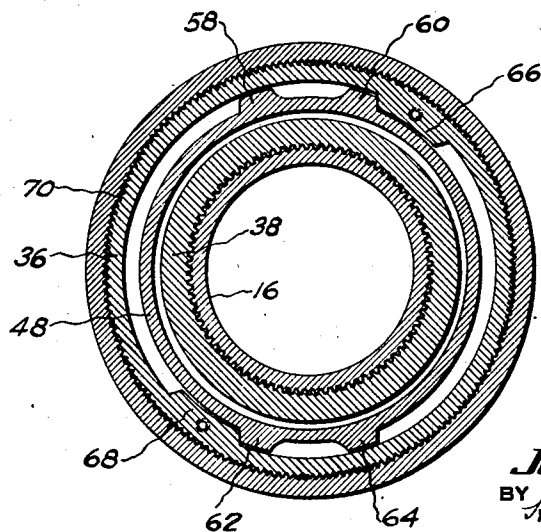


Fig. 4



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BLADE ADJUSTING MEANS

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11 Claims. (Cl. 170-163)

This invention relates to improvements in aeronautical propellers and has particular reference to an improved aeronautical propeller of the controllable-pitch type having its blades rotatably mounted in a hub structure and including mechanism for rotating the blades to change the propeller pitch.

An object of the invention resides in the provision in a propeller of the character indicated of improved means for accurately adjusting the pitch angles of the various blades with respect to each other.

A further object resides in the provision of improved means for obtaining an accurate aerodynamic balance between the blades of a controllable-pitch propeller.

A still further object resides in the provision in a controllable-pitch propeller of the character indicated of means for connecting the blades together for simultaneous pitch changing movements combined with means for obtaining a vernier adjustment of the pitch angle of the respective blades with respect to each other without interfering with the simultaneous pitch changing movements of all of the blades.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawings, in which like reference numerals are used to designate similar parts throughout there is illustrated a suitable mechanical embodiment for the purpose of disclosing the invention. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting or restricting the invention since it will be apparent to those skilled in the art that various changes in the illustrated construction may be resorted to without in any way exceeding the scope of the invention.

In the drawings,

Fig. 1 is an elevational view of the hub portion of a propeller to which the device of the invention may be applied.

Fig. 2 is an elevational view on an enlarged scale of a fragmentary portion of the propeller construction illustrated in Fig. 1 a portion thereof being broken away and shown in section to illustrate the application of the invention thereto.

Fig. 3 is a transverse sectional view on a somewhat reduced scale taken on the line 3-3 of Fig. 2.

Fig. 4 is a transverse sectional view on a reduced scale taken on the line 4-4 of Fig. 2, and

Fig. 5 is a sectional view similar to Fig. 2 showing the application of the invention to a some-

what different form of propeller from that illustrated in Fig. 2.

Referring to the drawings in detail, the numeral 10 generally indicates a propeller hub structure carrying a plurality of rotatably mounted blades, as generally indicated at 12 and 14. For operation the propeller is mounted upon an engine shaft 16 projecting from an engine 18 and extending through the center of the propeller hub structure 10.

The blades may be rotated in the hub structure to change the pitch of the propeller by any suitable or desired mechanism various hydraulic and electrical mechanisms for this purpose being well known to the prior art. An illustrative hydraulic mechanism of the character shown in Fig. 2 being particularly illustrated and described in United States Patent No. 2,296,288, for Controllable-pitch propellers, issued September 22, 1942, and a hydraulic mechanism of the character indicated in Fig. 5 being particularly illustrated and described in United States Patent No. 2,174,717, issued October 3, 1939, to Frank W. Caldwell et al. for Multiposition controllable pitch propeller.

Referring to the construction illustrated in Fig. 2, each of the propeller blades is secured in the hub structure by a suitable anti-friction thrust bearing, such as is indicated at 20, and is provided at its end within the hub with a gear element 22 which may be formed integrally with the blade or may be formed separately and secured to the blades against relative rotation by some suitable means such as the spline connection 24. In the construction illustrated in Fig. 2 the shank portion of the gear 22 constitutes a part of a hydraulic motor device having alternate vanes on the gear 22 and on a hub carried inner member disposed about the axis of the blade for rotating the blade to change its pitch. Such a pitch changing motor device is particularly illustrated and described in United States Patent No. 2,296,288 referred to above.

Each of the gears 22 in such a propeller construction, meshes with a gear 26 the axis of which is disposed at right angles to the axes of the gears 22 so that the gear 26 serves to rotationally connect all of the blades to insure that the pitch-changing movements of the blades will be simultaneous and coextensive. The gear 26 is rotatably supported in an anti-friction bearing, generally indicated at 28 mounted in an annular portion of the hub 10 and comprises an inner race member 30 mounted on a reduced annular portion of the gear, an outer race member 32 mounted in the hub and retained against axial movements by a

pair of annular pitch limit stop members 34 and 36, and a row of anti-friction elements, such as the balls 42 interposed between the races. The pitch limit stop members 34 and 36 are held in position by a hub closure member 38 and a nut 40 screw threaded into the end of the annular extension of the hub.

In the form of the invention shown in Fig. 2, in which the blades are turned by respective vane motors, an annular member 44 has a reduced annular portion 46 disposed between the gear 26 and the shaft 16 or between the gear and a propeller retaining nut screw threaded into the end of the shaft and has an enlarged annular portion 48 fitting within the limit stop members 34 and 36. The outer surface of the annular portion 46 is provided with splines or serrations 50 and one or more curved members such as 52 having serrations upon both sides thereof are disposed between the annular portion 46 and the serrated inner surface of a reduced sector portion 53 of the gear 26.

As is particularly shown in Fig. 3, the gear 26 is formed of a plurality of separate annular sections, there being one section for each blade carried gear 22 so that, in the case of a three bladed propeller, as illustrated, there are three parts to the gear 26, one part meshing with each blade carried gear, and a sufficient space is left between the adjacent ends of these gear parts to permit adjustment of the gear parts relative to each other. The ratios between the gears 22 and 26 are chosen so that each separate gear part contains a sufficient number of teeth to turn the gear 22 and its associated propeller blade through the desired pitch range. There are also a number of connecting elements 52 equal to the number of gear parts, these being indicated at 52, 54 and 56 in Fig. 3. In order to adjust the pitch of the various blades relative to each other the sectors constituting the gear 26 are meshed respectively with the blade carried gears and the blades are brought to the desired relative pitch angles. With the blades held in the desired relative position by the friction of the bearings 20 or otherwise, the member 44 is moved along the shaft 16 to a position convenient for the insertion of the locking sectors 52, 54 and 56. These sectors are then inserted, being moved slight distances circumferentially of the member 44 until a position is found in which the splines or serrations on the opposite sides of these sectors fit the splines within the sections of the gear 26 and the splines on the exterior of the annular portion 46 of the member 44.

The number of splines on these various surfaces is varied in a manner to give a vernier adjustment of the sectors 52, 54 and 56 relative to the gear 26 and member 44 so that the sectors 52, 54 and 56 can be inserted at substantially all operative positions of the member 46 relative to the various gear sectors. As a specific example, the gear parts may have notches cut in them in such a manner that there would be one hundred and fifty six (156) of them in three hundred and sixty degrees, and the annular portion 46 may have one hundred and fifty three (153) notches cut in three hundred and sixty degrees. This would mean that if the sector were moved along one notch of the annular portion 46 the gear portion would have to be moved only .045 degree in order to have the notches again mesh. Assuming a gear ratio of forty-four to forty-eight of the gears 22 and 26 this would mean that the blades could be adjusted in .049 degree steps. After the

sectors 52, 54 and 56 have been matched with the splines or serrations on the gear sectors and the member 44, the member 44 is moved to the operative position illustrated in Fig. 2 and the member 38 and nut 40 are then brought in position to retain the various parts in the assembled relation illustrated.

A portion 48 of the member 44 is provided with a plurality of outwardly projecting lugs as indicated at 58, 60, 62 and 64 in Fig. 4, which cooperate with inwardly projecting lugs 66 and 68 in the limit stop member 36 and similar inwardly projecting lugs in the limit stop member 34 to limit the rotational movements of the member 44 relative to the limit stop members 34 and 36 and thereby limit the rotational movements of the gear 26 relative to the hub structure 10 to thereby provide positive upper and lower limit stops for the pitch changing movements of the propeller blades, the members 34 and 36 being held against rotational movement relative to the hub structure by a suitable spline connection 70.

With the above described arrangement it is apparent that the propeller blades are interconnected for simultaneous coextensive pitch changing movements and may also be adjusted relative to each other to obtain complete aerodynamic balance of the propeller.

The form shown in Fig. 5 is the same as that shown in Fig. 2 and described above the only difference in the two disclosures being that in Fig. 5 the invention has been adapted to a type of controllable-pitch propeller in which the blades are turned in pitch changing directions by a single electric or hydraulic motor. In this arrangement the members 44 and 38 are omitted and the pitch changing cam member 72 such as is shown in United States Patent No. 2,174,717 referred to above, is provided with a reduced annular extension 74 provided with exterior splines or serrations 76 which engage with the splines or serrations on the inner surface of the locking segment illustrated, which may be any one of the segments 52, 54 or 56 and has been indicated as the segment 54. The sectors of the gear 26 are the same as those illustrated in Fig. 2 and described above and the bearing 42 and pitch limit stop members 34 and 36 may also be the same as those described above in connection with Fig. 2. Since the member 44 has been eliminated a plurality of lugs or extensions, one of which is indicated at 78 may be provided on the cam member 72, either rigidly connected thereto or formed integrally therewith, to cooperate with the internal extensions or abutments on the members 34 and 36 to provide positive limit stops for the pitch changing movements of the propeller blades. In this construction the inner seal 80, shown in Fig. 2, may be omitted and the outer seal 82 of Fig. 2 may be incorporated, as indicated at 84 between the flanged open end of the dome 86 and the adjacent end of the hub to which the dome is secured by the nut 88 screw threaded into the annular extension of the hub 10.

While a suitable mechanical embodiment of the invention has been hereinabove described and illustrated in the accompanying drawings for the purpose of disclosing the invention, it is to be understood that the invention is not limited to the particular arrangement so illustrated and described but that such changes in the size, shape and arrangements of the various parts may be resorted to as come within the scope of the subjoined claims.

Having now described the invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows:

1. In a controllable-pitch propeller having a hub structure, a plurality of blades rotatably mounted in said hub structure for pitch changing movements, a gear fixed on the hub end of each of said blades, means inter-connecting said blade gears for changing the pitch of all of said blades simultaneously, said inter-connecting means including a rotatable annular member, a plurality of separate elements, and a plurality of sector gears, one element and one sector gear associated respectively with each blade gear, and means for locking said elements, said sector gears and said annular member in adjusted position with respect to each other.
2. In a controllable-pitch propeller having a hub structure, a plurality of blades rotatably mounted in said hub structure for pitch changing movements, a gear on the hub included end of each blade, a separate gear sector meshing respectively with each blade gear, means supporting said sectors for rotation about an axis at right angles to the rotational axes of said blade gears for simultaneously changing the pitch of all of said blades, said sectors being movable relative to each other and said supporting means for changing the pitch of each individual blade, and means for locking said sectors in adjusted position relative to each other and to said supporting means.
3. The arrangement as set forth in claim 2 in which said locking means comprises an annular member having external serrations, an internally serrated flange on each gear sector, and a curved member having serrations on both sides thereof inserted between said annular member and each respective flange.
4. The arrangement as set forth in claim 2 in which said locking means comprises an annular member having external serrations, an internally serrated flange on each gear sector, and a curved member having serrations on both sides thereof inserted between said annular member and each respective flange said serrations being so spaced as to provide a vernier adjustment between said gear sectors and said annular member.
5. The arrangement as set forth in claim 2 in which said locking means comprises an annular member having external splines, an internally serrated flange on each gear sector, and a curved member having splines on both sides thereof inserted between said annular member and each respective flange.
6. Blade adjusting means for a controllable-pitch propeller comprising, rotatable mechanism interconnecting all of said blades, said mechanism comprising, an annular member, a plurality of arcuate sectional members concentric with said annular member and connected one with each of said blades, and a respective device between each said sectional member and said annular member for locking each sectional member in adjusted position on said annular member.
7. Blade adjusting means for a multi-bladed controllable-pitch propeller comprising, arcuate sectional members, one for each blade, operatively connected with said blades, an annular member concentric with said arcuate sectional members, said sectional members being secured to said annular member, and means for adjustably securing at least one of said sectional members to said annular member in the relative position to another sectional member incident to the desired pitch relation between the one blade to which said adjustable sectional member is connected and another blade of said propeller.
8. In a controllable-pitch propeller having a hub, a plurality of blades carried by said hub for pitch changing movements, an element fixed to each blade, and means interconnecting all of said elements and movable during pitch changing movement to maintain a simultaneous and coextensive pitch changing movement of all of said blades; said interconnecting means comprising an annular supporting member, separate members carried by said annular supporting member and movable relative thereto and connected with said blade carried elements, and means for relatively adjusting and securing said separate members with respect to said annular supporting member, whereby means are provided for effecting minor adjustments of the pitch angles of the various blades relative to each other.
9. In a controllable-pitch propeller having a hub, a plurality of blades carried by said hub for pitch changing movements, anti-friction means associated with each blade for securing the respective blades to the hub, an element fixed to each blade between the respective anti-friction means and the hub axis, blade connecting means movable in a plane parallel to the axes of rotation of said blades interconnecting said blade carried elements for simultaneous and coextensive movement, and anti-friction means supporting said blade connecting means in said hub; means for effecting minor adjustments of the pitch angles of said blades relative to each other comprising, a supporting portion and relatively movable portions carried by said supporting portion and operatively associated with respective blade carried elements and constituting portions of said blade connecting means, and means accessible from the end of said hub when said hub, said blades and said blade interconnecting mechanism are operatively assembled for releasing said movable elements from said supporting element and securing said movable elements to said supporting element in adjusted position.
10. Individual blade pitch changing means for a controllable pitch propeller having a plurality of blades and an annular rotatable device for simultaneously changing the pitch of all of said blades, said device comprising, an annular member, a plurality of separate blade pitch changing members around said annular member and connected one with each of said blades, and a plurality of separate sectors interposed between and connecting each said blade pitch changing member and said annular member, said sectors being individually adjustable circumferentially of said annular member and said blade pitch changing members for individually changing the pitch of each blade.
11. In a propeller having a plurality of blades, an annular rotatable device for simultaneously changing the pitch of all of said blades, said device comprising, an annular member, a plurality of separate pitch changing sectors around said annular member and connected one with each of said blades, and a locking sector member interposed between and connecting one of said pitch changing sectors and said annular member, said locking sector being adjustable circumferentially of said annular member for changing the pitch of one of said blades.

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