Jan. 16, 1945. H. M. McCOY 2,367,230

CONTROLLABLE PITCH-CHANGE MECHANISM FOR DUAL ROTATION PROPELLERS

Filed Dec. 9, 1943

FIG. 1

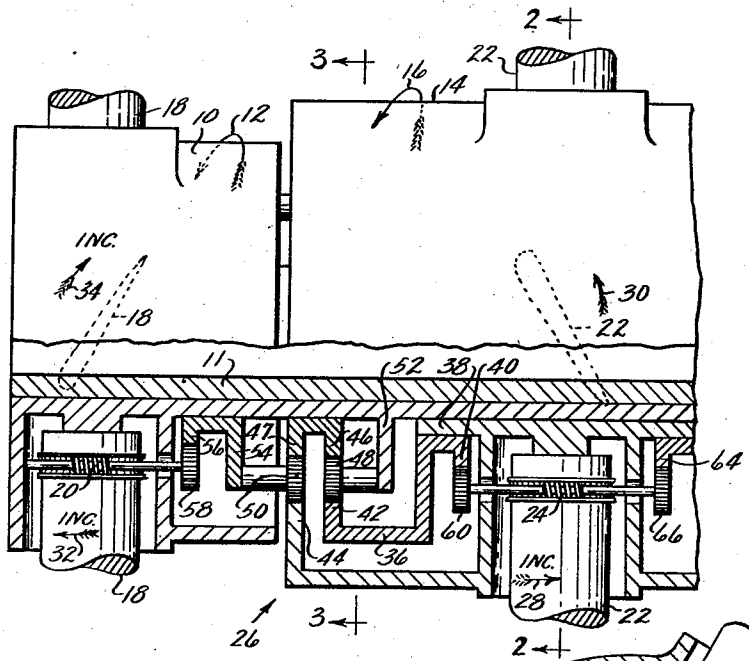


FIG. 2

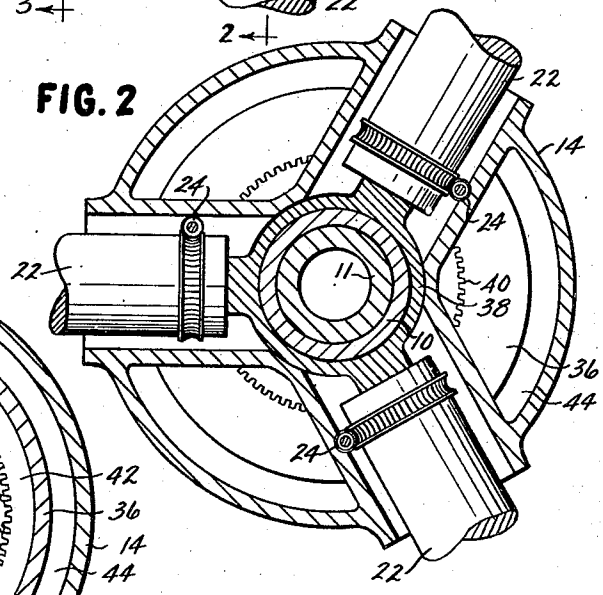
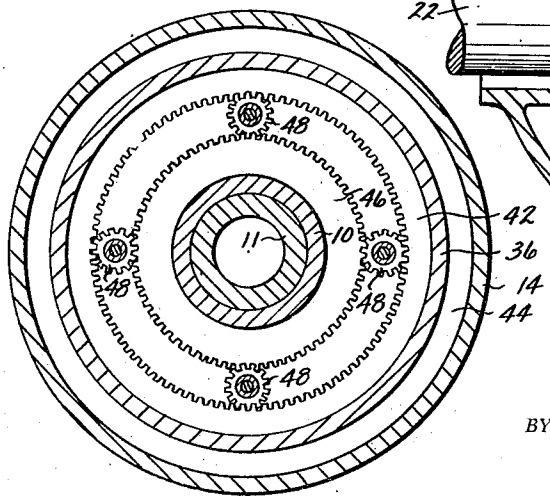


FIG. 3



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CONTROLLABLE PITCH-CHANGE MECHANISM FOR DUAL ROTATION PROPELLERS

Howard M. McCoy, Fairfield, Ohio

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9 Claims. (Cl. 170—135.6)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to dual rotation propellers and more particularly to mechanism for controlling the pitch of the blades of both of the propellers simultaneously.

By "dual rotation" is commonly meant a pair of oppositely rotating propellers operating in close tandem, mounted on concentric shafts and rotating at equal speeds.

Mechanism for accomplishing this purpose as heretofore proposed is complicated and costly, and it is therefore an object of this invention to provide a device which will have less parts and therefore be of lighter weight and greater simplicity.

It has been found that, in a device of this character, it is advantageous, in order to cancel propeller torque effects, to have an arbitrary and variable differential pitch setting between the front and rear propeller blades. For pitch settings used at take-off and low forward velocities there should be but very little if any difference. At high forward velocities there should be several degrees difference with the setting of the rear propeller lower than that of the front. It is desirable to have the pitch differential vary directly between the small differential at low velocities to the large differential at high velocities. It is therefore an object of this invention to so construct and arrange the mechanism that this advantage may be had.

Other objects and advantages will be disclosed as the invention is described in detail and reference is had to the drawing, wherein,

Fig. 1 is a longitudinal axial section through a dual rotation propeller constructed according to subject invention, the view being more or less schematic.

Figs. 2 and 3 are transverse sections taken at 2—2 and 3—3, showing the arrangement of the gearing.

Like reference characters refer to like parts throughout the drawing.

The dual rotation propeller, which is selected as an illustrative embodiment of this invention, comprises an outboard or front propeller hub 10, which is fast on a shaft 11 and is rotatable clockwise, as indicated by the arrow 12, and an inboard or rear propeller hub 14, rotatable on the sleeve portion of the hub 10 anticlockwise, as indicated by the arrow 16.

When the terms "clockwise" or "anticlockwise" are hereinafter employed they shall be intended to mean clockwise or anticlockwise when viewed from right to left in the drawing. The relatively heavy gearing required for connecting the front and rear hubs to each other and to the engine, for opposite rotation, is not shown.

Supported on the front hub 10, the blades 18 are rotatable about their axes by the worm 20, while similar blades 22 are carried on the rear hub 14 and are rotatable about their axes by the worm 24. Worms 20 and 24, in the instant embodiment, are both right hand.

A relatively light weight gear-set 26, which, for convenience in description, may be referred to as the dual rotation gear-set, is provided for drivably connecting the worms 20 and 24 to each other, this gearing being so arranged that when the worm 24 is rotated to turn the blades 22 in a pitch increasing direction, as indicated by the arrow 28 or 30, the worm 20 will be rotated to turn the blades 18 in a pitch increasing direction, as indicated by the arrow 32 or 34, the same result being achieved whether the hubs 10 and 14 are stationary or are in a state of opposite rotation about the axis of the hubs 10 and 14.

The gear-set 26 includes a cylindrical member 36 which is freely rotatable on a sleeve portion 38 of the rear hub 14, and comprises integrally an external gear 40 and an internal gear 42, a second internal gear 44 integral with the rear hub 14, a pair of drivably joined sun gears 46 and 47 freely rotatable on a portion of the front hub 10, two planet pinions 48 and 50 meshing respectively with the internal gears 42 and 44 and the drivably connected sun gears 46 and 47, and two planet pinion carriers 52 and 54 for respectively rotating the planet pinions 48 and 50 on their axes while revolving them around the sun gears 46 and 47 and within the ring gears 42 and 44. Carrier 52 is fast on a portion of the hub 10 while carrier 54 is freely rotatable thereon. Carrier 54 has an external gear 56 integral. Pinions 58 and 60 drivably connect the gear-set 26 to the worms 20 and 24, respectively, whereby rotation of the worm 24 rotates the worm 20 equally but oppositely whether the hubs 10 and 14 are stationary or are rotating oppositely. Where it is desirable that pitch change of the rear propeller blades 22, through a given angle, cause pitch change of the front propeller blades 18 through a slightly greater angle, this may be accomplished by changing the ratios between certain of the gears, for instance, by adding one or more teeth to the gear 56 and subtracting one or more from the pinion 58. In such case the gears should be set so that both propellers come to zero pitch at the

same time, whereby the higher the pitch the more pitch difference will be had between the two propellers.

Gears 64 and 66 are part of a gear mechanism for rotating the worm 24 of the rear propeller for initiating pitch change, but since this mechanism forms no part of subject invention, it is not herein further shown or described. The system herein shown for connecting the two parts of a dual rotation propeller for unitary blade adjustment is shown and described, but not claimed, in my copending application Serial No. 511,935, filed November 27, 1943.

The operation of the mechanism shown and described is substantially as follows:

Let it be assumed that the front hub 10 is rotating clockwise and the rear hub 14 anticlockwise, both at the same speed, and that, for the time being, no pitch change is taking place.

Since there is no pitch change taking place, the internal gears 42 and 44 both rotate anticlockwise at the same speed, and both carriers 52 and 54 rotate clockwise at the same speed, whereby the pinions 48 and 50 merely rotate anticlockwise on their axes at the same speed and rotate the sun gears 46 and 47 clockwise faster than the hub 10.

If the worm 24 is now rotated one turn clockwise to increase the pitch of the blade 22, the internal gear 42 will gain part of an anti-clockwise turn on the internal gear 44. This part turn gain of gear 42 causes the pinion 48 to gain approximately one anticlockwise turn on the turns it would normally have made when no pitch change was taking place.

Since the carrier 52 has a fixed one to one opposite rotation with respect to gear 44, the one turn anticlockwise gain of the pinion 48 causes a gain over the normal number of clockwise turns of the sun gear 46, which in turn causes the carrier 54 to gain part of a turn over its normal clockwise turns, whereby the pinion 58 is rotated anticlockwise approximately one turn with respect to the hub 10, which increases the pitch of the propeller 18.

A similar analysis of the directions of rotation will show that rotation of the worm 24 anticlockwise to decrease the pitch of the blade 22 will rotate the worm 20 clockwise to decrease the pitch of the blades 18, whether the propellers are then rotating or are stationary.

I claim:

1. In an aircraft propeller mechanism having two close-coupled, coaxial, tandem, contrarotating propeller hubs, one front hub and one rear hub, with a plurality of propeller blades in each hub having their roots rotatable in bearings in said hubs, mechanism for drivably connecting said roots, whereby rotation of the roots of one propeller in one direction rotates the roots of the other propeller in the other direction, said mechanism comprising, in combination, a front worm wheel on a front propeller-blade shank, a rear worm wheel on a rear propeller-blade shank, a front worm in mesh with said front worm wheel, a rear worm in mesh with said rear worm wheel, a front-worm shaft, a rear-worm shaft, front and rear worm shaft pinions on the front and rear worm shafts respectively, a planet pinion carrier freely rotatable on the front hub, an external gear fast on said carrier and in mesh with the front worm shaft pinion, a second planet pinion carrier fast on the front hub, front and rear planet pinions on the first and second said planet pinion carriers, respectively, a sun gear freely rotatable on said front hub and having a face width sufficient to mesh with both said planet pinions, an internally toothed gear fast on said rear hub and in mesh with the front planet pinion, a second internally toothed gear freely rotatable on said rear hub and in mesh with the said second planet pinion, a second external gear fast on said second internal gear and in mesh with said rear worm shaft pinion, and means to rotate said rear worm shaft.

2. In an aircraft propeller mechanism having two close-coupled, coaxial, contrarotating propeller hubs, one front hub and one rear hub, with a plurality of propeller blades in each hub, said blades having blade shanks rotatable in bearings in said hubs, an improved mechanism for drivably connecting said blade shanks, whereby rotation of the blade shanks of one propeller in one direction is coincident with rotation of the blade shanks of the other propeller in the other direction, said mechanism comprising, in combination, a planet pinion carrier freely rotatable on the front hub, an external gear fast on said carrier, a second planet pinion carrier fast on the front hub, front and rear planet pinions on the first and second said planet pinion carriers respectively, a sun gear freely rotatable on said front hub and having a face width sufficient to mesh with both said planet pinions, an internally toothed gear fast on said rear hub and in mesh with the front planet pinion, a second internally toothed gear freely rotatable on said rear hub and in mesh with the said rear planet pinion, a second external gear fast on said second internal gear, front speed reducing gearing connecting the first said external gear to the blade shanks of the front hub, rear speed reducing gearing connecting the second said external gear to the blade shanks of the rear hub, and means to impart rotation to the rear speed reducing gearing.

3. In an aircraft propeller mechanism having two coaxial, tandem, contrarotating propeller hubs, one front hub and one rear hub, with a plurality of propeller blades in each hub said blades having their blade shanks rotatable in bearings in said hubs, an improved mechanism for drivably connecting said blade shanks, whereby rotation of the blade shanks of one propeller in one direction is coincident with rotation of the blade shanks of the other propeller in the other direction, said mechanism comprising, in combination, a planet pinion carrier freely rotatable on the front hub, an external gear fast on said carrier, a second planet pinion carrier fast on the front hub, front and rear planet pinions on the first and second said planet pinion carriers, respectively, a sun gear freely rotatable on said front hub and having teeth adapted to mesh with both said planet pinions, an internally toothed gear fast on said rear hub and in mesh with the front planet pinion, a second internally toothed gear freely rotatable on said rear hub and in mesh with the said rear planet pinion, a second external gear fast on said second internal gear, front gearing connecting the first said external gear to the blade shanks of the front hub, rear gearing connecting the second said external gear to the blade shanks of the rear hub, and means including a portion of said rear gearing to impart rotation to the second said external gear.

4. In an aircraft mechanism having two close-coupled, contra-rotating propeller hubs, one front hub and one rear hub, with a plurality of propeller blades in each hub having blade shanks

rotatable in bearings in said hubs, an improved mechanism for drivably connecting said blade shanks whereby causing rotation of the blade shanks of one propeller in one direction causes rotation of the blade shanks of the other propeller in the other direction, said mechanism comprising, in combination, a planet pinion carrier freely rotatable on the front hub, a second planet pinion carrier fast on the front hub, front and rear planet pinions on the first and second said planet pinion carriers respectively, a sun gear concentric with and freely rotatable with respect to said hubs and having teeth in mesh with both said planet pinions, an internally toothed gear fast on said rear hub and in mesh with the front planet pinion, a second internally toothed gear freely rotatable with respect to said rear hub and in mesh with the said rear planet pinion, gearing connecting the first said planet pinion carrier to the blade shanks of the front hub, a power receiving shaft, and gearing connecting the said second internally toothed gear to the blade shanks of the rear hub and to the power receiving shaft.

5. In an aircraft propeller mechanism having two close-coupled contrarotating propeller hubs, one front hub and one rear hub, with a plurality of propeller blades in each hub having blade shanks rotatably supported by said hubs, an improved mechanism for drivably connecting said blade shanks, whereby rotation of the blade shanks of one propeller in one direction may not take place except upon rotation of the blade shanks of the other propeller in the other direction, said mechanism comprising, in combination, a planet pinion carrier rotatable freely about the axis of said hubs, a coaxial planet pinion carrier fast on said front hub, front and rear planet pinions on the first and second said planet pinion carriers respectively, a sun gear element coaxial with said hubs and freely rotatable with respect thereto and having teeth in mesh with both said planet pinions, an internal gear coaxial with and fast on said rear hub and in mesh with said front planet pinion, a second internal gear coaxial with and freely rotatable with respect to said hubs and in mesh with said rear planet pinion, rotation transmitting means connecting the first mentioned planet pinion carrier to the blade shanks of the front hub, a rotatable power input means and rotation transmitting means connecting the said second internal gear to the blade shanks of the rear hub and to the rotatable power input means.

6. In a dual rotation propeller mechanism having close-coupled, coaxial, propeller hubs, one front hub and one rear hub with a plurality of propeller blades in each hub having blade shanks rotatably supported by said subs, an improved mechanism for drivably connecting said blade shanks, whereby rotation of the blade shanks of one propeller is coincident with rotation of the blade shanks of the other propeller, said mechanism comprising, in combination, a front planet pinion carrier rotatable freely about the axis of said hubs, a coaxial rear planet pinion carrier fast on said front hub, front and rear planet pinions on the front and rear planet pinion carriers respectively, a sun gear element coaxial with said hubs and freely rotatable with respect thereto and having teeth in mesh with both said planet pinions, an internal gear coaxial with and fast on said rear hub and in mesh with said front planet pinion, a second internal gear coaxial with and freely rotatable with respect to said hubs and in mesh with said rear planet pinion, rotation transmitting means connecting the said front planet pinion carrier to the blade shanks of the front hub, rotation transmitting means connecting the said second internal gear to the blade shanks of the rear hub, and means to impart rotation to one of said rotation transmitting means.

7. In a dual rotation propeller mechanism having one front hub and one rear hub with a plurality of propeller blades in each hub having blade shanks rotatably supported by said hubs, an improved mechanism for so connecting said blade shanks to the same source of rotation that rotation of the blade shanks of one propeller in one direction is coincident with rotation of the blade shanks of the other propeller in the other direction, said mechanism comprising, in combination, a front planet pinion carrier rotatable freely about the axis of said hubs, a coaxial rear planet pinion carrier fast on said front hub, front and rear planet pinions on the front and rear planet pinion carriers respectively, a sun gear unit coaxial with said hubs and freely rotatable with respect thereto and having teeth in mesh with both said planet pinions, an internal gear fast on said rear hub and in mesh with said front planet pinion, a second internal gear freely rotatable relative to said hubs and in mesh with said rear planet pinion, means drivably connecting the said front planet pinion carrier to the blade shanks of the front hub, and means drivably connecting the said second internal gear to the blade shanks of the rear hub.

8. For a dual rotation propeller having one front and one rear hub with a plurality of propeller blades in each hub having blade shanks rotatably supported by said hubs, an improved gear mechanism for drivably connecting said blade shanks for coincident rotation, said gear mechanism comprising, in combination, a first planet pinion carrier rotatable freely about the axis of said hubs, a coaxial second planet pinion carrier fast on one of said hubs, first and second planet pinions on the first and second planet pinions carriers respectively, a sun gear coaxial with said hubs and freely rotatable relative thereto and having teeth in mesh with both said planet pinions, an internal gear coaxial with and fast on one of said hubs and in mesh with said first planet pinion, a second internal gear coaxial with and freely rotatable relative to said hubs and in mesh with said second planet pinion, means drivably connecting the said first planet pinion carrier to the blade shanks of one hub, and means drivably connecting the said second internal gear to the blade shanks of the other hub.

9. The gear mechanism of claim 8 wherein the ratio of the gearing is such that when the rear hub is rotated through a given angular movement, the front hub will rotate through a slightly greater angular movement.

HOWARD M. McCOY.