March 30, 1943. E. LINEHAN 2,315,213

VARIABLE PITCH PROPELLER

Filed April 15, 1939 2 Sheets-Sheet 1

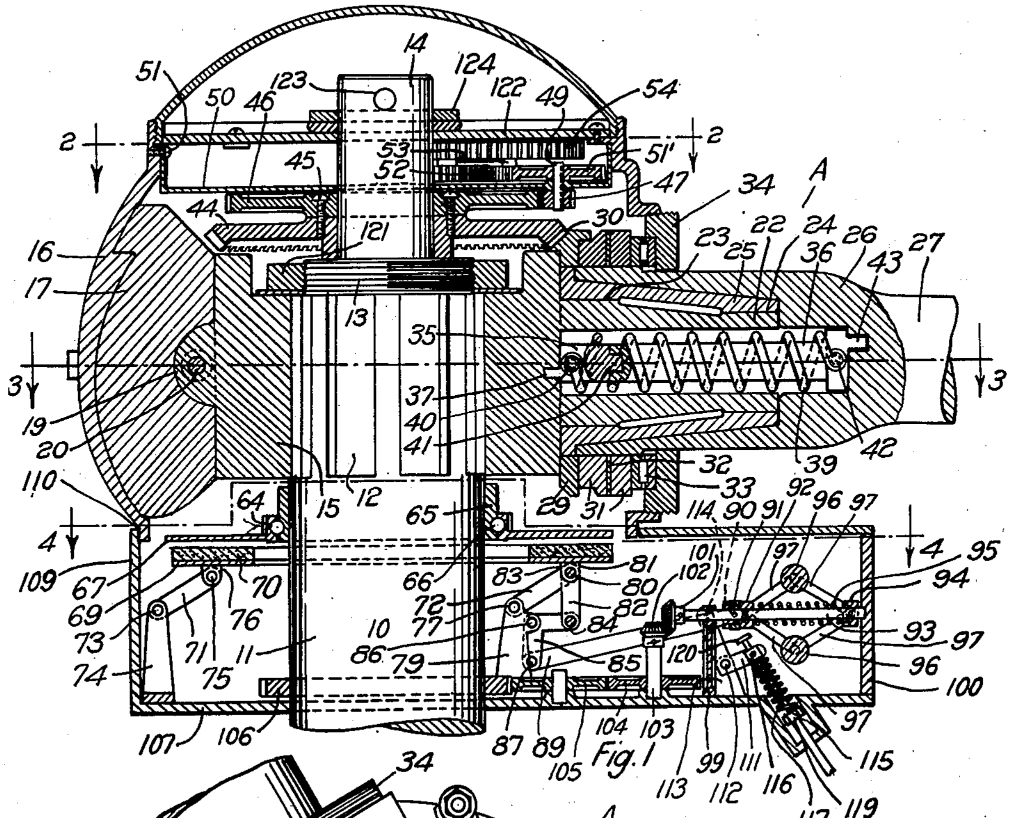

Fig. 1

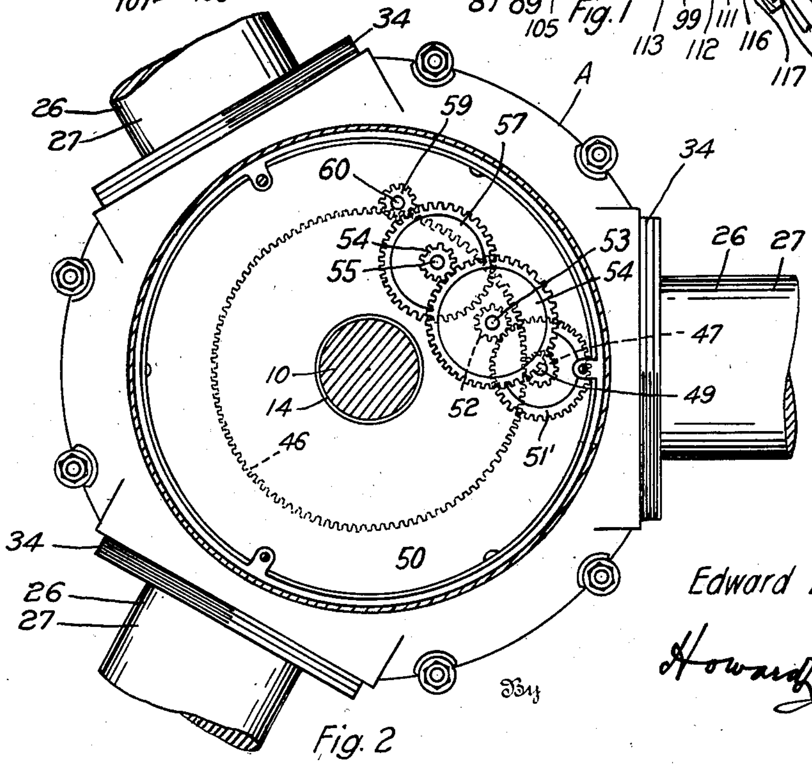

Fig. 2

Inventor

Edward Linehan

By Howard L. Fischer

Attorney

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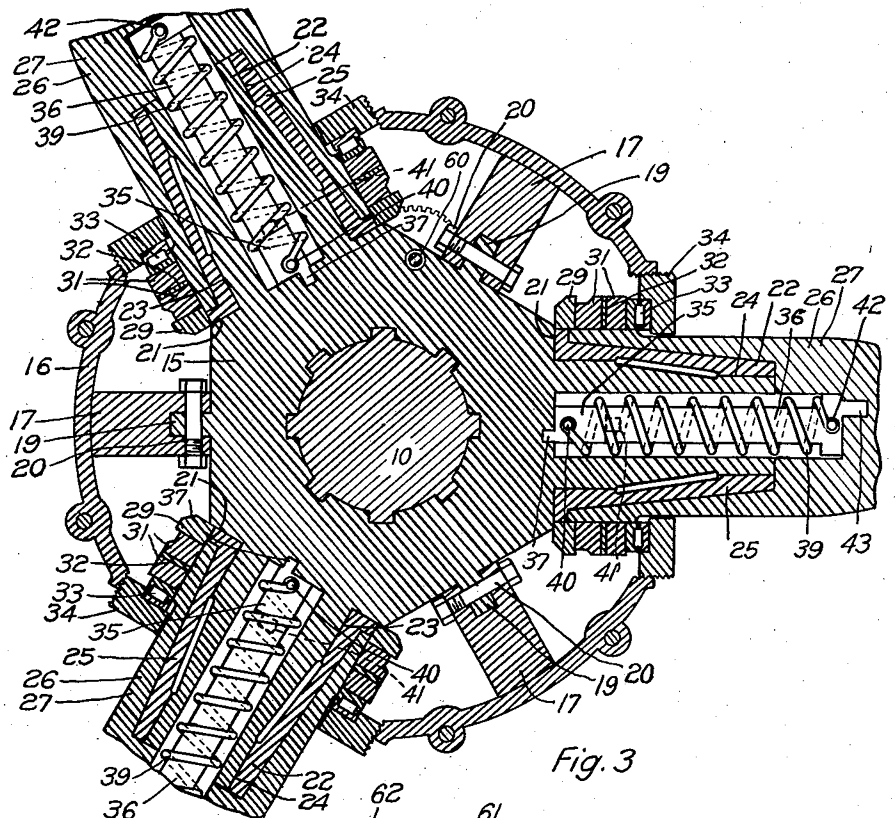

Fig. 3

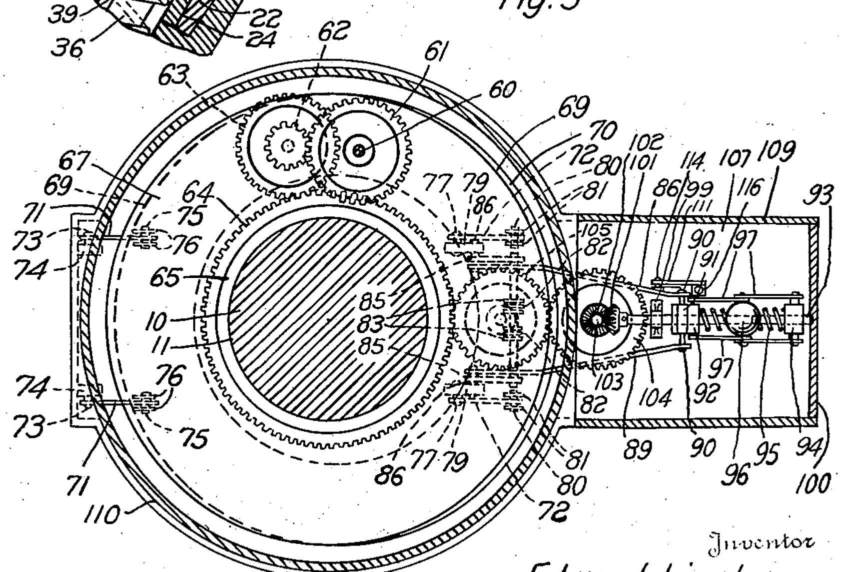

Fig. 4

Inventor

Edward Linehan

By Howard Fischer

Attorney

Patented Mar. 30, 1943

2,315,213

UNITED STATES PATENT OFFICE

2,315,213

VARIABLE PITCH PROPELLER

Edward Linehan, Hillman, Minn.

Application April 15, 1939, Serial No. 267,999

2 Claims. (Cl. 170—163)

My invention relates to an improvement in variable pitch propeller wherein it is desired to provide a propeller in which the pitch is automatically variable and which is capable of permitting movement of the blade into a full-feathering position in case the motor should cease to function.

Automatic pitch propellers have been constructed in the past. Many of these propellers are capable of accomplishing much the same result to that desired in the present invention, but my construction is designed to require an exceedingly small number of parts to function in the proper manner.

It has been found that unless the propeller mechanism is properly constructed, the blades of the propeller will not move into full-feathering position in case one of the motors should cease to function. In any other position of the blades, the angularity of the blades cause the blades to rotate the crank shaft of the motor, causing the motor to draw fuel from the fuel tanks which ordinarily is not exploded. An accumulation of unburned fuel will then be forced into the hot exhaust pipe, creating danger of an explosion and endangering the lives of the persons in the plane. Furthermore, when the motor ceases to function for any reason, it is desirable that the rotation of the motor be stopped as soon as possible, in order to prevent further damage of the motor by any parts of the same which might be broken.

It is an object of my invention to provide a device which will automatically permit the blades to move into full-feathering position in an extremely short space of time, and which if desired may be operated manually to cause such full-feathering of the blades to take place.

It is a purpose of my invention to operate the propeller mechanism to control the angularity of the blades by means of a rotating disc drum or element and to create friction or in any suitable way to change the speed of rotation of this disc with respect to that of the propeller shaft. When my propeller is of preferred construction, the reduction in speed of this collar disc or other element with respect to the speed of the propeller shaft will tend to rotate the blades into full-feathering position. In order to rotate the blades into opposite extreme position, the rotatable drum disc or element rotates at a greater speed than the propeller shaft for a short period of time, automatically pivoting the propeller blades into proper operative position.

It is a purpose of my invention to provide a variable pitch propeller mechanism in which the propeller blades are normally urged into one extreme position, and to provide automatic and manually controllable means to rotate the propeller blades from this extreme position to full-feathering position in which the blades are substantially flat upon a plane substantially through the axis of the propeller shaft.

It is a further feature of my invention to provide a governor means capable of actuating a friction creating mechanism providing a tendency to rotate the blades toward full-feathering position. In the rotation of the propeller shaft, if the speed of rotation of the shaft increases, additional friction is created to rotate the blades to greater angularity, while if the speed of rotation of the propeller shaft decreases, the friction tendency will be lessened, permitting the propeller blades to rotate in a manner to decrease the pitch of the same. Thus, the propeller blades are adjusted in angularity in accordance with variations in the thrust of the propeller blades in operation and may also be manually controlled.

It is a purpose of the preferred form of my invention to provide a spring or resilient means for resiliently urging the blades of the propeller toward low pitch and to provide means for moving the propellers toward a higher pitch. When this means for moving the propeller toward a higher pitch is removed, the propeller will automatically move back into low pitch without any means except the spring means described and the normal tendency of the blades to move in this direction when other pressure is released, causing such movement.

These and other objects and novel features of my invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of my specification:

Figure 1 is a cross-sectional view through my variable pitch propeller mechanism, the section being taken on a plane through the axis of the propeller shaft.

Figure 2 is a cross-sectional view through my variable pitch propeller mechanism, the position of the section being indicated by the lines 2—2 of Figure 1.

Figure 3 is a section taken on a plane parallel to Figure 2, the position of the section being indicated by the line 3—3 of Figure 1.

Figure 4 is another section taken on planes parallel to the sections in Figures 2 and 3, the position of the section being indicated by the line 4—4 of Figure 1.

The variable pitch propeller mechanism A is shown of a particular shape and conformation, but may of course be widely changed in shape and proportion to fit varying requirements. The variable pitch propeller mechanism A is designed to be mounted upon the propeller shaft 10 which is shown having a substantially cylindrical portion 11, a spline portion 12, a threaded portion 13, and an attaching portion 14, preferably cylindrical in section. The splined portion 12 of the shaft 10 extends through a spider 15 to which the propeller blades are secured in a manner which will be later described, and to which the outer casing 16 of the mechanism A is secured through spacing blocks 17.

The spider 15 is best illustrated in Figure 3 of the drawings and is shown provided with ears or lugs 19 to which the spacer blocks 17 are attached by means of bolts 20 or other suitable means. The spacer blocks 17 are provided with slots or apertures into which the lugs or ears 19 extend, and the bolts 20 extend through portions of the spacer block 17 on either side of these apertures for accommodation of these lugs 19 as well as through the lugs.

Between the attachment with the spacer block 17, the spider is provided with flattened surfaces 21 from which the sleeves 22 extend. The sleeves 22 are preferably each formed with a pair of bearing surfaces 23 and 24 which engage cooperating bearing surfaces on a tapered bushing 25 recessed in the end or shank 26 of the propeller blades 27.

A ring 29 is secured to the end of the shank 26 of each propeller, and this ring 29 is provided along a segmental portion of its periphery with gear teeth 30 as indicated in Figure 1 of the drawings. A pair of supporting rings 31 having a relatively flexible washer 32 therebetween are interposed about the shank 26 of the propeller between the ring 29 and the anti-friction bearing 33. The anti-friction bearing 33 is preferably of the split type so that it may be replaced, and is held in place by a threaded ring 34 which may also be formed of two halves if desired so that it may be removed from the propeller shank without removing the ring 29. When the rings 34 have been threadably secured to the casing 16, the natural tendency for the blades 27 to be pulled outwardly by centrifugal force is overcome by engagement with the anti-friction bearing 33 and even while considerable centrifugal force is urging the blades outwardly, they may be turned easily because of the bearings 33.

Within each of the sleeves 22 and extending into the body of the propeller blades 27, I provide a pair of relatively rotatable shafts 35 and 36. The shaft 35 is provided with an off-set pin or key 37 which prevents rotation of the shaft 35 with respect to the spider 15, and one end of the spring 39 is anchored at 40 thereto. A projecting end 41 on the shaft 35 extends into an axial aperture in the shaft 36 so that the shafts 35 and 36 may be supported in alignment, but relatively rotatable. The outer end of each spring 39 is secured at 42 to the shaft 36. The shaft 36 is secured by an off-set pin 43 or any other suitable means to the propeller blade 27.

It will be noted that the shafts 35 and 36 are so constructed as to not interfere with axial movement of any of the blades 27, but they are so positioned as to create a tendency for the blade 27 to move toward low pitch position. If no other forces act upon the blade, the blade will remain in low pitch position. The gear teeth 30 on the ring 29 are designed to engage a bevel gear 44 encircling the projecting end 14 of the propeller shaft 10. Attached to this bevel gear by bolts 45 or any suitable means, I provide a spur gear 46. These gears 44 and 46 are rotatable with respect to the shaft 10 and while they normally rotate with this shaft, they are not keyed or otherwise attached thereto. A pinion 47 upon a shaft 49 engages the gear 46 and is extremely small with respect thereto so that the shaft 49 will rotate a number of times for each revolution of the gear 46.

A partition member and support 50 is illustrated secured by bolts 51 or other suitable means to the casing 16. The shaft 49 extends through the partition 50, and a gear 51′ is mounted on the opposite side of the partition from the pinion 47. The partition 50 thus forms a support for the shaft 49. The gear 51′ is constantly in mesh with a pinion 52 best illustrated in Figure 2 of the drawings, which rotates upon the axis 53 and which causes rotation of the gear 54. The shaft 53 is supported in any suitable manner as by the partition 50.

A second shaft 55 is mounted in any suitable manner as by the partition 50 and supports a pinion 56 in mesh with the gear 54 and the gear 57 which is rotated with the pinion 56. The gear 57 rotates a pinion 59 mounted upon a shaft 60 which extends downwardly through the spider 15 to support a gear 61 as illustrated in Figure 4 of the drawings. Rotation of the gear 61 acts to rotate the pinion 62 which in turn rotates the gear 63 which is in mesh with the gear 64 extending about the cylindrical portion 11 of the shaft 10. A sleeve 65 is secured to the shaft 10 and supports an anti-friction bearing 66 which in turn suports the gear 64 and the disc 67 secured thereto.

Slightly below the disc 67 I provide a ring 69 supporting a ring of felt 70 or other suitable material. The ring 69 is supported as illustrated in Figures 1 and 4 by a pair of links 71 and a second pair of links 72. The links 71 are pivotally attached at 73 to fixed supports 74, while they are pivotally secured at their other end 75 to ears 76 upon the ring 69. The links 72 are pivotally connected at 77 to fixed supports 79 and are pivotally secured at their other end 80 to ears 81 on the ring 69. It will be noted that by this arrangement, the ring 69 remains parallel to the disc 67 at all times, and that the links 71 and 72 permit the ring to be moved toward or away from the disc 67.

To actuate the ring 69 toward or away from the disc 67, I provide a pair of links 82 pivoted between ears 83 upon the ring 69 and pivoted at 84 to bell crank levers 85. The levers 85 are pivoted at 86 to the fixed supports 79 and on the opposite side of their fixed pivots 86 are pivoted at 87 to link means 89. The links 89 are secured by pins 90 or other suitable means to a ring 91 which is formed as a part of the collar 92, but is rotatable with respect thereto. The collar 92 is longitudinally slidable upon a shaft 93, but is designed to rotate with the shaft 93. A fixed collar 94 is secured near an end of the shaft 93 and a spring 95 is interposed between the fixed collar 94 and the slidable collar 92. Governor weights 96 are secured by pairs of links 97 between the fixed collar 94 and the slidable collar 92 in such a manner that rotation of the shaft 93 will tend to throw the weights 96 outwardly and throw the movable collar 92 toward the fixed collar 94. This movement will cause longitudinal movement of the ring 91 and the attaching means 90 so as to draw the links 89 toward the fixed collar 94. This action will tend to pivot the bell crank 85, raising the link 82 and moving the ring 69 upwardly toward the disc 67. If the movement is sufficient, it will cause friction between the felt 70, which is preferably impregnated with oil or other suitable material, and the disc 67, tending to slow down the disc 67 with respect to the speed of rotation of the shaft 10. Any variation in the speed of rotation between the disc 67 and the shaft 10 causes rotation of the gear 63, the pinion 62, the gear 61 and the vertical shaft 60. Rotation of the vertical shaft 60 causes rotation of the pinion 59, gear 57, pinion 56, gear 54, pinion 52, gear 51, and pinion 49, which causes rotation of the gear 46 and the bevel gear 44. This in turn causes rotation of the ring 29 bearing the teeth 30, thus acting to vary the pitch of the propeller in a manner to increase the same.

The shaft 93 is mounted between a fixed support 99 and an end support 100, and is provided with a bevel gear 101 cooperating with a similar cooperating bevel gear 102 on a shaft 103. The gear 104 is mounted upon the gear 103 which operates the idle gear 105 which in turn engages the gear 106 on the shaft 10. Rotation of the shaft 10 rotates the gear 106, the gears 105 and 104, shaft 103, and bevel gears 102 and 101, to rotate the shaft 93. This causes operation of the governor which controls the movement of the ring 69. The shaft 103 and the fixed supports 99 are secured to the nose plate 107, secured in fixed position in the front of the motor. A housing 109 is designed to surround the cylindrical portion 11 of the shaft 10 and to contain the governor, the ring 69, and the mechanism for operating this ring. The housing 16 is of course rotatable and rotates in an aperture 110 designed for this purpose.

In order to provide a manual control for varying the pitch of the blades 27, I provide a bell crank 111 pivoted at 112 to a fixed support 113. One end of this bell crank is pivotally connected to one of the links 89 at the point 114. A manual control cable 115 extends through a pivoted lug 116 on the other end of the bell crank lever 111. By pushing on the control cable 115, the end of the bell crank lever 111 attached to the cable is pivoted upwardly, pivoting the bell crank in a counter-clockwise direction, causing the bell crank lever 85 to pivot in a clockwise direction, and pulling the ring 89 away from the disc 67 to withdraw friction therefrom. By pulling on the control cable 115, the bell crank lever 85 is moved in a counter-clockwise direction, raising the ring 69 and creating additional friction against the disc 67. Thus when it is desired to increase the pitch manually, the control cable 115 is pulled, whereas if it is desired to decrease the pitch, the control cable is pushed inwardly, drawing the ring 69 away from the disc 67. The springs 39 are then free to pivot the blades 27 toward low pitch position.

A spring 117 is interposed between a nut 119 on the cable 115 and the lug 116 on the lever 111. If the control cable 115 is pushed inwardly, the spring 117 creates a tendency to pull the ring 69 away from the friction disc 67. As the governor operates, the bell crank lever 111 is moved in a clockwise direction by the link 89. This movement compresses the spring 117 and accordingly the governor must act against the spring 117 as well as the spring 95. Accordingly, the governor can operate at a higher rate of speed without forcing the ring 69 against the friction disc 67. Thus as the ship is started from the ground, the control cable 115 may be pushed inwardly and the propeller shaft 10 will be permitted to act at a higher rotative speed without increasing the pitch of the propeller blades 27.

Similarly, the spring 117 may operate to provide the opposite function and to provide a tendency to push the ring 69 against the disc 67 if the control cable 115 is pulled outwardly. Thus if it is desired to manually increase the pitch of the blades to an angle more than would normally be assumed by the blades at a particular speed of rotation of the shaft 10, the control cable 115 is pulled outwardly, accomplishing this result. By pulling the cable 115 farther out, the head 120 of the cable will engage against the lug 116 to cause the felt on the ring 69 to engage the friction disc 67 to move the propeller blade into full-feathering position.

The spider 15 is held in place by a nut 121 on the threaded portion 113 of the shaft 10. A partition 122 parallel to the partition 50 covers the gears in the outer end of the propeller and a suitable pin 123 engaging a washer 124 assists in holding the propeller shaft and casing 16 in proper relationship.

The operation of my device is believed clearly understood from the foregoing description of the construction of the device. When the speed of rotation of the shaft 10 increases, the gear 106 on this shaft acts through the gears 105 and 107 to rotate the shaft 103 which acts through the bevel gears 102 and 101 to rotate the governor shaft 93. This increase of speed throws the governor weights 96 outwardly, acting through the levers 97 to move the ring 91 of the collar 92 to the right as viewed in Figure 1. This action acts through the pivot pins 90 to move the links 89 to the right, pivoting the bell crank levers 85 in a counter-clockwise direction and acting through the links 82 to move the supporting links 71 and 72 in a counter-clockwise direction. This action raises the friction pad 70 into contact with the disc 67, creating a frictional engagement between the disc 67 and the friction material 70 of the stationary friction disc 69.

The disc 67 and the series of gears connected therewith normally rotate without relative rotation together with the shaft 10. As the friction surface 70 tends to slow down the disc 67 and cause this disc to rotate slower than the shaft 10, relative rotation of the various gears is necessary. A small angular movement of the disc 67 causes an extremely small angular movement of the gear 44 because of the gear train interposed therebetween. A slowing down of the disc 67 causes the slowing of the gear 64 connected thereto. This causes rotation of the gear 63 which in turn rotates the pinion 62 connected thereto. The pinion 62 rotates the gear 61 which rotates the shaft 60 extending through the spider 15. Rotation of the shaft 60 acts through the pinion 59 to rotate the gear 57. The pinion 56 rotates with the gear 57 and engages the gear 54. The pinion 52 rotates with the gear 54 and engages the gear 51'. The pinion 47 rotates with the gear 51' and rotates the gear 46. The bevel gear 44 is connected to the gear 46 and rotates therewith. The bevel gear 44 is connected to cooperable gear teeth 30 upon the ring 29, rotatable with the propeller blades 27. Thus through the train of gears a slight pressure upon the disc

67 tending to slow the speed of rotation of this disc will act to rotate the blades 27 axially.

The pressure required to change the pitch of the blades to increase the pitch thereof is dependent upon the resistance by the blades to such rotation. When the friction surface 70 of the disc 69 is moved away from the disc 67, the springs 39 within the blades tend to rotate these blades toward low pitch. Movement of the blades 27 toward low pitch will normally cause an increase in the speed of rotation of the shaft 10, which in turn will act through the governor in the manner described to increase the pitch of the blades. Thus the angle of the pitch of the blades is greatly dependent upon the speed of rotation of the shaft 10 and the resistance of the blades to any change in pitch.

In the manual operation the cable connector 115 is provided to pivot the bell crank 111 to move the link 89 by hand in place of through governor control. The manner in which the links 89 are operated by the governor weights 96 has been described. These links 89 are also attached to the bell crank 111 which is controlled manually through the cable 115.

If it is desired to increase the pitch manually to an angle more than would normally be assumed by the blades at the particular speed of rotation of the shaft 10, the control cable 15 is pulled outwardly, the head 120 thereof pivoting the bell crank 111 in a clockwise direction, pivoting the links 89 to the right as illustrated in Figure 1, which in turn pivots the bell cranks 85 in a counter-clockwise direction, acting through the links 82 to pivot the supporting links 71 and 72 in a counter-clockwise direction and raising the disc 69 bearing the friction surface 70 into engagement with the disc 67. Thus by pulling on the control cable 115, the blades may be axially rotated in the same manner as if the speed of rotation of the shaft 10 had been increased. The amount to which the blades 27 may be pivoted by the control cable 115 is dependent upon the length of time the friction disc 70 is held in contact with the disc 67. The blades may thus be merely actuated to increase the pitch thereof, or may be moved into feathering position.

Because of the series of gears interposed between the propeller blades and the disc 67, only a small amount of pressure is necessary to vary the pitch. It has been found that oil soaked felt may be used upon the ring 69 to provide the necessary friction, and that such felt will stand up under the necessary pressure. If necessary, other materials may be used, however, to provide the necessary friction between the ring 69 and the disc 67 to act to change the pitch of the blades 27.

In accordance with the patent statutes, I have described the principles of construction and operation of my variable pitch propeller; and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that this is only illustrative of a means of carrying out my invention, and that obvious changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A variable pitch propeller comprising a propeller shaft, a blade support mounted thereon, blades mounted on said support, gear means rotatably connecting said blade means to rotate the same axially in unison, a large gear means connected to said gear means, a pinion engaging said large gear means, a gear large relative to said pinion rotatable with said pinion, a second pinion engaging said last named large gear, a rotatable disc encircling said shaft, means connected to said second pinion engageable with said disc to rotate therewith, said gears and disc normaly rotating in a body with said shaft, a stationary friction element engageable with said disc, and governor means driven by said shaft and operable upon an increase in speed of rotation of said shaft, to engage said disc to create relative rotation between said gears and to rotate said blades axially.

2. A variable pitch propeller comprising a propeller shaft, a blade support mounted thereon, blades mounted on said support, gear means rotatably connecting said blades to rotate said blades axially in unison, a large gear means connected to said gear means, a rotatable disc encircling said shaft, a series of reduction gears connected to said rotatable connecting means, said gears and disc normally rotating in a body with said shaft, a stationary friction disc element engageable with said disc, and governor means driven by said shaft moving said friction disc element against said disc upon an increase in speed of said shaft to create relative rotation between said gears and to rotate said gears axially.

EDWARD LINEHAN.