3,170,521
FEATHERED PROPELLER CONTROL
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3 Claims. (Cl. 170—160.29)

This invention relates to aeronautical propellers having variable pitch propeller blades and adapted to be moved to a feathering position and particularly to means for preventing the propeller from rotating when in the feathered position.

It is an object of this invention to provide means in a variable pitch propeller for preventing the propeller from rotating when in the feathered position.

A still further object of this invention is to provide in a propeller as described a purely mechanical system for automatically and continuously seeking zero r.p.m. of a feathered propeller.

A still further object of this invention is to provide in a variable pitch propeller as described means for rotating the propeller blades about their longitudinal axis while in a feathered position in order to obtain a blade angle to prevent the propeller from rotating about its rotating axis.

It is still a further object of this invention to provide a self-seeking zero r.p.m. feather angle in a variable pitch propeller blade by the use of a mechanism which is characterized as being relatively simple to manufacture, economical and capable of rugged use.

Other features and advantages will be apparent from the specification and claims and from the accompanying drawings which illustrate an embodiment of the invention.

FIG. 1 is a schematic illustrating a variable pitch propeller blade and its control mechanism to which this invention has been utilized.

FIG. 2 is an isometric and partial sectional view illustrating the invention.

Variable pitch propellers capable of being placed in a feathered position are generally well known in the art and as equally well known ideally, the feathered position is that position which offers the least resistance to the airstream during flight of the aircraft. When the blades are placed in the feathered position, it is customary to hold a fixed blade angle by bracing mechanism of the hydraulic or mechanical type which prevents the propeller blade from seeking a lower propeller angle. However, as is well known, the feathered angle selected is generally unsatisfactory because some rotation about the propeller axis will be evidenced. This rotational movement, known in the art as windmilling, imposes a considerable amount of drag to the aircraft impeding its flight, as well as imposing loads on the engine. This is particularly a critical problem in propeller installations driven by turbo-types of power plants. Hence, it is desirable and in some installations absolutely necessary to provide means for preventing the propeller from rotating about its rotational axis; i.e., preventing windmilling. Obviously, when the propeller is placed in the feathered condition, any power derived as a result of the rotation of the propeller is automatically cut off. We have found that by employing this invention to a variable pitch propeller no external power is necessary for automatically adjusting the blade angle in a position to seek zero rotation of the propeller.

The propeller incorporates mechanical feedback means for feeding back the blade angle to a servo control unit. If such a system is utilized, it is possible to modify the existing feedback system and mechanism in order to achieve the zero rotation. While the invention will be described in connection with a propeller that incorporates this type of feedback mechanism described above, it is to be understood that the invention is not limited thereto.

Now referring to FIG. 1 which shows this invention in its preferred form showing a propeller generally indicated by numeral 10 as having a plurality of propeller blades circumferentially mounted in hub 14 in a well-known manner. The propeller contains a dome assembly 16 which surrounds a pitch changing piston 18 operatively connecting the pitch changing cam mechanism 20 rotably mounted therein. Bevel gear 22 is mounted on one end of cam 20 and rotates therewith and engages a bevel gear 24 carried on the root of the blade 12. As shown in the drawing, engine 26 is coupled to the propeller 10 by any suitable means generally illustrated by numeral 28 for rotating the propeller and obviously the propeller blades carried therewith about the propeller center line.

In order to rotate the propeller about its longitudinal axis or change pitch, pitch changing piston 18 responds to the position of distributor valve 30 by virtue of delivering pressurized fluid to either side of pitch changing piston 18 through the fluid conducting lines 32 and 34. The pressurized fluid issuing from pump 36 to line 38 and into the distributor valve is directed to the fore or aft end of piston 18 by virtue of movement of the spool 40 of distributor valve 30. For example, when the spool is moved to the left, high pressure fluid discharging from line 38 communicates with line 32 for directing high pressure fluid into chamber 42 located in the dome. This urges the piston to move to the right for rotating the blade 12 about its longitudinal axis. Of course, the rotational movement is obtained by the use of cam 20 and the attendant bevel gears 22 and 24. Simultaneously, the fluid evidenced in chamber 44 located on the aft side of piston 18 communicates with drain via line 34 through distributor valve 30 and line 46.

In order to rotate the propeller blade in the opposite direction spool 40 is positioned to the right for directing high pressure fluid from pump 36 into line 34 and ultimately into chamber 44 to act on the aft end of piston 18 for moving the same to the left to cause the rotational movement of cam 20 for varying the pitch of blade 12.

Simultaneously, when spool 40 is at the right position, it is obvious from an inspection of the drawing that fluid in chamber 42 will be directed to drain through distributor valve 30 via lines 32 and 48 and returned back to the reservoir 50.

Controls for variable pitch propellers are well known in the art and basically, the control serves to maintain the propeller r.p.m. at a constant value. This is accomplished by sensing the r.p.m. of the propeller by a speed responsive device and comparing that speed with a preselected value. The control holds the speed at that value by changing the pitch of the propeller blade in response to any error created by the speed responsive device. Devices such as this are well known in the art and for more detail to such devices reference is hereby made to Patent No. 2,664,960, granted to M. E. Longfellow et al., on January 5, 1954, and Patent No. 2,850,103, granted to D. R. Pearl, on September 2, 1958.

Still referring to FIG. 1, the control system for maintaining the r.p.m. of the propeller at a constant value is shown as basically comprising a suitable speed governor 60 which senses the speed of the engine and the position of the pilot lever 62 and comparing both signals for controlling the position of governor pilot valve 64. Pilot valve 64 comprises spool element 66 having a pair of lands 68 and 70 cooperating with ports 72 and 74 respec-
tively for directing high pressure to either side of piston 76 of servo motor 78, as well as connecting the fore or aft chamber in servo motor 78 to drain. When the pilot valve 64 is moved downwardly, high pressure developed by pump 80 is directed through line 82 to line 84 and into the lower chamber 86 of the servo motor 78 and simultaneously, land 64 uncovers line 88 which communicates with fluid in chamber 90 for directing the fluid to drain through line 82 to chamber 90 via line 88 and directing fluid evidenced in chamber 86 to drain via lines 84 and 94.

The ultimate effect is that piston 76 is moved in either upward or downward direction and attached rack gear 98 is moved to rotate pinion gear 160. The pinion gear is attached to a shaft 102 which engages a suitable spline mechanism 104. The spline mechanism serves to translate the spool 40 of distributor valve 30. From the foregoing it is apparent that movement of piston 76 will cause spool 40 to direct fluid to the daisy wheel of the propeller for effectuating a pitch change movement. Thus, if an increase of speed is evidenced by the governor 60, the control will respond to the speed error for effectuating a pitch change movement to reduce the error for maintaining the r.p.m. of the propeller at the speed dictated by the pilot lever 62.

Feedback is achieved by incorporating a feedback shaft 108 extending coaxially about the propeller center line which has the cam 20 and carries at its aft end spur gear 110. The spur gear engages another spur gear 112 which, in turn, engages gear 114 and this gear train serves to drive the differential gearing 116. Ring gear 118 contains internal teeth 120 which engage the teeth of gear 114, and external gears 122 which engage the differential gear 124 for driving the differential. As shown in the drawing, the other input to the differential is through gear 126 driven by the propeller by virtue of the gear 128 which is attached to the spline member 104 for repositioning spool 40. Hence, by the differential and the feedback members, the position of the propeller blade is relayed back to the control system so that whenever an equilibrium or steady-state condition exists the lands of spool valve 40 will be on line-on-line position with its cooperating parts in distributor valve 30.

In accordance with this invention we provide means for preventing the propeller from windmilling by assuring that the blade will seek a zero r.p.m. position when the propeller blade is placed in its feathered position. To accomplish this we provide spur gear 140 which engages a set of teeth formed on member 118. Gear 140 is supported by shaft 142 which extends into the braking mechanism 144. Braking mechanism 144 may be of any suitable type of brake such as a friction brake which responds to the position of lever 146 by action of its connecting linkages 148 and 150. When lever 146 is pivoted about pivot point 152, the brake will be engaged for preventing shaft 142 and ultimately gear 140 from rotating. This will lock ring gear member 118 into place and prevent it from rotating while allowing gears 114, 112, 110, bevel gears 22 and 24 to rotate.

The operation of the self-seeking zero r.p.m. mechanism will now be described. Assume that the propeller has been placed in the feathered condition and that the brake 144 is energized. When the propeller has reached the true feathered position, the blades will be rotated such that the leading edge is parallel to the airstream and offers the least resistance thereto and no rotational movement of the propeller will be evidence. If, however, a change in attitude, angle of attack of the airstream, drag or the like causes the propeller to rotate, gear 114 to rotate and hence rotate blade 12 about its longitudinal axis in a direction to return the propeller to a zero r.p.m. condition.

Now referring to FIG. 2, which shows in more detail a propeller utilizing this invention as comprising a dome assembly 202 and a hub assembly 204. A plurality of blades 206 is circumferentially supported in the hub about the propeller blade axis. The bevel gear 208 is mounted on the root of blade 206 and engages bevel gear 210 carried by feedback shaft 212. Mounted on the opposite end of feedback shaft 212, which shaft is coaxially mounted about the center line of the propeller axis, is gear 214. Gear 214, in turn, engages gear 216 which, in turn, engages gear 218 which, in turn, engages the internal teeth of ring gear 220. Ring gear 220 carries a set of external gears which engage spur gear 224 mounted on shaft 226. Shaft 226 connects to braking mechanism 228 which may carry a suitable braking shoe 230 and cooperating friction member 232. Engagement of the brake may be effected in any suitable manner and is not important to an explanation of this invention. As was explained in connection with FIG. 1, when the propeller is placed in the feathered condition, the invention serves to automatically and continuously seek a zero r.p.m. of the propeller. Preferably, the sequence of operation is as follows:

1. While in the nonfeathered condition the brake is disengaged until feathering operation is initiated to cause the blade to move to its feathered position to an angle which will be greater than the highest desired feathered angle. The angle should be limited by a mechanical stop which may be imposed by limiting movement of the pitch changing piston. The brake is then engaging locking gear 220 into position.
2. Gears 218 and 216 will rotate counterclockwise (looking aft) and clockwise about their respective axes when the propeller windmills, which is occasioned by overfeathering the propeller as was mentioned in the step above. As the propeller is turned clockwise (looking aft) about its axis, it will cause the feedback shaft 212 to turn counterclockwise. The gear mesh between bevel gear 210 and 208 causes the blade to decrease angle until zero rotation about the propeller rotational axis occurs.
3. A change in flight attitude or a speed requiring a higher pitch may be brought about by clockwise windmilling about the rotational axis and a direction of rotation for gears 218, 216, etc., would be the reverse of those described immediately above. The blade angle will then increase until zero rotation occurs.
4. When it is desirable to unfeather, the feather brake is released allowing the feedback mechanism to function in its normal operating condition.

What has been shown by this invention is a simplified means characterized as being a positive method of seeking zero rotational speed when the propeller has been placed in a feathered condition. Since it is customary to provide feedback mechanisms to certain propeller installations, it is a simple expedient to modify such feedback mechanism to accomplish zero rotation by incorporation of this invention.

It is to be understood that the invention is not limited to the specific embodiment heretofore illustrated and described, but may be used in other ways without departing from its spirit as defined by the following claims.

We claim:
1. A variable pitch propeller having a plurality of blades movable to a feathered position, a hub supporting said blades, means in said hub for automatically main-
taining the propeller in a nonrotational position when the blades are in a feathered position, said means responsive to rotational movement of said propeller for adjusting the pitch of the blade to either a higher or lower blade angle to prevent said rotational movement.

2. For a variable pitch propeller having a plurality of blades movable to a feathered position, mechanical means for automatically adjusting the pitch of the blades to the feathered position and keeping the propeller in a nonrotational position by adjusting the pitch in a decrease or increase angular position when said blades are in the feathered position, said mechanical means comprising a shaft mounted coaxially with the rotational axis of the propeller, a first gear carried by said shaft and a second gear spaced from said first gear also carried on said shaft, said first and second gears being rotateable with said shaft, a gear carried on the end of the blades engaging said first gear, a first spur gear engaging said second gear, a second spur gear engaging said first spur gear, a ring gear engaging said second spur gear and braking means retarding movement of said ring gear.

3. For an aeronautical propeller having a hub, a plurality of blades movable to a feathered position circumferentially supported around said hub, an elongated shaft in said hub extending along the axis of rotation of said propeller, a first gear carried on the root of each of said blades extending in said hub, a second gear carried on the end of said shaft engaging said first gear for causing said blade to rotate about its longitudinal axis, zero revolution per minute seeking means responsive to rotational movement of said propeller for rotating said shaft and automatically controlling the pitch of the propeller blades to a higher or lower blade angle for keeping said propeller at zero revolutions per minute, and actuating means connected to said last mentioned means for actuating said last mentioned means.

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