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PITCH CONTROL SYSTEM

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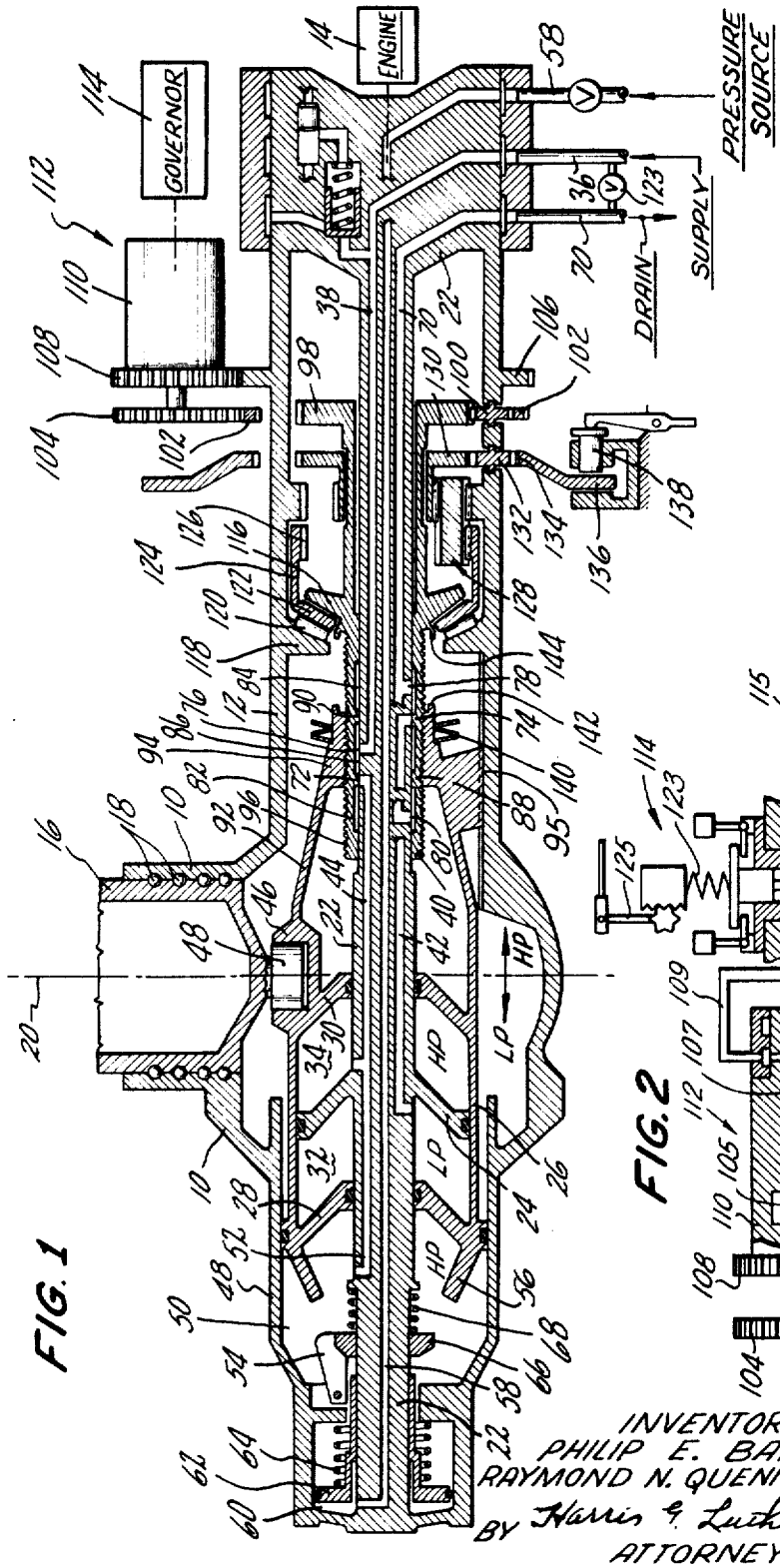


FIG. 1

FIG. 2

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PITCH CONTROL SYSTEM

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26 Claims. (Cl. 170—160.32)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A hydraulic actuator is actuated by supplying fluid thereto and bleeding fluid therefrom by a valve operatively connected to a rod and nut in threaded engagement. The rod is rotatable relative to and translatable together with the nut and carries valve means for directing fluid to and from the actuator. Input mechanism rotates the rod to position the valve means for controlling the position of the actuator and feedback is effectuated by a direct connection to the actuator that translates the nut which, in turn, carries the rod to return the valve to its balanced or null position. Loss of hydraulic fluid locks the actuator in position by virtue of the threaded engagement between the rod and nut. The actuator can be moved rectilinearly by rotating one element relative to the other element or breaking either the nut or the rod, while the other element rotates.

This invention relates to a propeller pitch control system and particularly to a system having both hydraulic and mechanical pitch changing means and mechanism utilizing a portion of the mechanical pitch changing means as a mechanical pitch lock.

An object of the invention is mechanism by which the propeller may be feathered after complete failure of the pitch changing motor or its energy source.

Another object is a positive mechanical pitch lock which is immediately effective within about 1° of blade movement.

Another object is a pitch changing mechanism having a feed-back connection from the propeller blade to the control for the pitch changing motor and means utilizing that connection for adjusting the propeller pitch by means of the pitch changing motor, adjusting the propeller pitch mechanically and effecting a pitch lock.

Other objects and advantages will be apparent from the following specifications and the attached drawings in which:

FIGURE 1 is a schematic representation of a structure incorporating the invention.

FIG. 2 is a schematic representation of the governor control mechanism for the pitch control system.

This invention is shown as incorporated in an aeronautical propeller having the usual hub **10** mounted on, secured to or integral with a shaft **12** connected with an engine **14** in any suitable well-known manner for driving the shaft and the propeller. The hub **10** supports any desired number of blades **16**, although only one is shown for purposes of illustration, in any well-known manner for pitch changing rotation about an axis extending longitudinally of the blade and for rotating the blades with the hub about the axis of the shaft **12** for providing propulsion. As shown, the blades **16** are supported by ball bearings **18** in the hub **10** for rotation about the pitch changing axis **20**. A tube **22** is secured at both ends to the shaft **12** against movement relative to the shaft **12**. This shaft is provided with fluid passages and ports for the distribution and control of hydraulic fluid to a pitch changing motor and to a low pitch stop as will be described in more detail hereinafter. The tube **22** is provided adjacent the hub **10** and blade **16** with a piston **24** fixed on the tube. A cylinder **26** closed at both ends surrounds the piston **24** and together form a pitch changing motor. The ends **28** and **30** of the cylinder **26** form a fluid tight sliding joint with the exterior of the tube **22** to thereby form a low pitch chamber **32** and a high pitch chamber **34** within the piston **26** and separated by the piston **24**. Hydraulic fluid under pressure from any suitable and well known source introduced through the supply line **36** and the conduit **38** in the tube **22** may be directed by a movable valve member **40** through either the conduit **42** to the low pitch chamber **32** to move the cylinder **26** in a direction to reduce the propeller pitch or through a channel **44** to the chamber **34** to move the cylinder **26** in the opposite direction to increase the propeller pitch. The cylinder **26** is connected in a well known manner by means of yoke or cam **46** and a roller **48** with the blade **16** for transforming the linear movement of the cylinder **26** into a rotary pitch changing movement of the blade **16**. The outer circumference of the cylinder **26** forms a fluid tight joint with the inner surface of a cylindrical extension **48** of the hub **10** so as to form a chamber **50** at the end of the cylinder **26**. Fluid under pressure is led through the extension **52** of the channel **44** into the chamber **50** at the time it is introduced into the chamber **34** to assist in moving the propeller blades toward high pitch. This additional area is desirable because of the inherent tendency of the propeller blades to reduce their pitch under the influence of centrifugal twisting moments which tendency must be overcome before the blades can be moved toward high pitch.

If desired a low pitch stop may be provided and which may take any suitable form. For purposes of illustration, the well known pivoted, retractible stop fingers **54** cooperating with the cylinder extension **56** are used to limit the low pitch movement to a preselected value in the normal operation of the propeller. Introduction of fluid under pressure through line **58** to a chamber **60** will urge piston **62** to the right, from the position shown in the figure maintained by the spring **64**, into contact with the wedge **66** and move the wedge **66** to the right against the action of spring **68** to withdraw the wedge from under the fingers **54** to permit retraction of the fingers **54** and the movement of cylinder **26** to the left beyond the low pitch stop position and into reverse position if desired.

The movable valve member **40** is slidable axially of the tube **22** and cooperates with ports in that tube to selectively direct fluid to the chamber **32** and drain fluid from the chambers **34** and **50** or direct fluid to the chambers **34** and **50** and drain fluid through channels **70** from the chamber **32**.

Channel **44** and its extension **52** terminates in a port **72** on the surface of tube **22** and channel **42** terminates in a port **74** on the surface of the tube **22**. Channel **38** terminates in a port **76** on the surface of tube **22** and channel **70** terminates in ports **78** and **80** on the surface of the tube **22**. The inner surface of the movable valve member **40** is provided with annular channels or grooves **82** and **84** always in fluid connection with the drain ports **78** and **80**. A groove **86** between grooves **82** and **84** is provided on the interior surface of the movable valve member **40** and is always in fluid flow connection with the ports **76** of the pressure line **38**. A land **88** cooperating with port **72** is provided between

the grooves **82** and **86** and a land **90** between the groove **84** and the groove **86** cooperating with the port **74**. The movable member **40** has an inoperative or null position as shown in the drawing in which no fluid is fed to or drained from the cylinder **26** or only sufficient fluid is fed to maintain the propeller against any pitch changing movement. The movable member **40** is connected with the cylinder **26** and through a connection formed by the yoke or cam **46** and roller **48** with the blades **16** by a sleeve **92** forming an extension of the cylinder **26**. The sleeve **92** terminates in an internally threaded nut **94** cooperating with mating threads on the exterior of the movable member **40**. These mating threads form a helical connection of helical members and provides a feedback from the propeller blades such that any tendency of the blades to move from a position determined by the null position of the movable member **40** will move the member **40** from the null position and return the blades to the selected pitch and the member **40** to the null position.

The movable member **40** is mounted for rotation about the tube **22** and may be rotated by any of the well known mechanisms, such as the single acting governor and double acting motor and gearing shown in Longfellow et al. Patent No. 2,664,960 or the double acting motor and double acting governor shown in Gaubis et al. Patent No. 3,170,521, for imparting controlled relative rotation to two concentric rotating members. For purposes of illustration this mechanism is shown, in this application, as a gear **98** secured to or integral with an extension of the member **40** meshing with a pinion **100** carried by the shaft **12** for transferring motion from the inside to the outside of the shaft **12**. The pinion or pinions **100** mesh with an internal gear **102** having external teeth meshing with a controlled gear **104**. A gear **106** fixed on or integral with shaft **12** meshes with a gear **108** concentric with the gear **104**. Gear **108** is connected with the housing **110** of a gear or vane pump or motor **112** and gear **104** is connected with the gear or impeller **105** of the pump or motor. A governor **114** of any suitable type, such as disclosed in Jedrziewski Patent No. 2,636,566 if member **112** is used double acting or Woodward Patent No. 2,204,640 if member **112** is used single acting responsive to the speed of the shaft **12** or the engine **14** will drain fluid from or introduce pressure fluid to, or block flow of fluid into or from the pump or motor **112** to rotate the gear **98** in one direction or the other with respect to the shaft **12** or hold the gear **98** against rotation relative to the shaft **12**. As shown in FIG. 2, in which the pump or motor **112** is shown as a single acting vane pump or motor for simplicity of showing although it might equally well be a gear pump or motor or other single or double acting positive displacement pump or motor, the single acting pump outlet **107** is connected by line **109** with the control port **111** of the governor **114** and the pump inlet is connected with a reservoir **113**. The governor is supplied in the well-known manner with pressure by the pump **115** and drains to reservoir **113** through drain port **117**. The governor is supplied with the usual fly weights and speeder spring **121** and governor adjusting means **125**. Rotation of the gear **98** and the member **40** in one direction with respect to the shaft **12** and the nut **94** which is fixed against rotation with respect to the shaft **12** and blade support **10** by any suitable means such as splines **95** in a well-known manner such as shown in Gaubis Patent No. 3,153,454 or Barnes et al. Patent No. 3,163,231 will cause the member **40** to be threaded into or out of the nut **94** and move the member **40** in one direction longitudinally along the shaft **22** assuming the propeller blade is in a fixed position. Such motion will move the valve member **40** from its null position and also change the relation of the blade pitch and the linear position of said member **40** causing a change in propeller pitch which will restore the valve member **40** again to its null position. Rotation of the gear **98** and the member **40** in the opposite direction will of course translate the valve **40** in the opposite direction along the shaft **22** to thus change the propeller pitch in the opposite direction.

The member **40** is provided with an upstanding flange **116** secured to or formed integral with the member **40**. The shaft **12** is provided with a depending flange member **118** secured to or integral with the shaft **12**. The inboard face of the depending flange **118** forms or supports one race of a bearing having a roller **120**. The other race **122** of the bearing is formed on the end of a sleeve **124** mounted for rotation within the shaft **12**. An internal gear **126** is formed on the other end of the shaft **124** and forms part of a planetary reduction gear indicated generally at **128** which terminates in a gear **130**. The gear **130** meshes with a series of planets **132** carried by the shaft **12** to bring the drive from the inside to the outside of the shaft **12**. The planets **132** mesh with an internal gear **134** carried by a flange **136**. Normally the flange **136** and the race **122** and all the connecting means therebetween rotate as a unit with the shaft including the roller **120** and the depending flange **118**.

Upon any failure, accidental or intentional in a well-known manner such as shown in British patent to Charles, Milner and Fairhurst No. 517,372 by opening valve such as valve **123** connecting the pressure line **36** with the drain line **70**, of the hydraulic system including the piston **24** or the cylinder **26** or the hydraulic supply source, the centrifugal twisting moment of the blades due to the rotation of the propeller will, through the yoke or cam **46** and roller **48** connection, cause the cylinder **26**, the connection **92** and the sleeve **40** to move as a unit bodily toward the left in the illustrated embodiment. Such movement will cause the upstanding flange **116** to contact the race **122**. The depending flange **118** will act as a stop preventing any further movement of the member **40** by the blades **16** after the upstanding flange **116** contacts the race **122**. Flange **116** is normally spaced from the race **122** by an amount substantially equal to or slightly greater than the width of the port **72** or the land **78** or by an amount slightly greater than the motion required to saturate the valve **40**. This clearance may be any desired amount and is normally, relatively small, being substantially the equivalent of about 1° of blade pitch.

Upon failure of the hydraulic system and after the flange **116** has been forced into contact with the blade race **122** the propeller may be turned to a high pitch position or in an increased pitch direction under the influence of a rotating or windmilling propeller by means of a brake **138** which may be operated to hold the flange **136** against rotation. Rotation of the propeller will then rotate race **126** and by means of friction between the race **126** and the flange **116**, which friction may be augmented by teeth or friction material if desired, will rotate the flange **116** and the member **40** with respect to the shaft **12**, and the nut **94**. Rotation of the threaded member **40** inside of the nut **94** will force the nut **94** along the tube **22** and the shaft **12** and move the propeller blades **16** in a pitch increasing direction to a feathered position where the windmilling will stop and the blade will cease rotating. As long as the brake **138** remains applied, any rotation of the propeller will change the propeller pitch to bring the blades to a feathered position in which there will be no further windmilling. The flange **136** acts through the reduction gear **128** so as to rotate the blade race and friction element **122** slightly faster than or preferably slightly slower than the rotation of the shaft **12**. It will be appreciated that the centrifugal twisting moment of the blades **16** must be sufficient to force the flange **116** to the left with sufficient force to provide enough friction between the flange **116** and the blade race **122** to rotate the movable valve

member **40** with respect to the shaft **12** and the nut **94**. As the propeller blades approach the feathered position and slow down in their rotation the centrifugal twisting moment will be reduced and in order to maintain the frictional contact between the flange **116** and the race **122**, Belleville springs which are carried by the nut **40** contact the inturned flange **118** and maintain a load on the flange **116** and the race member **122** which is absorbed through the roller bearing **120**.

The operation of the mechanism is as follows: During normal, on speed operation, the input drive gear **102** is held fixed relative to gear **106** and the propeller shaft **12** by the propeller control motor or pump **112**. The low ratio gear system **98**, **100**, **102** holds the screw **96** and the control valve **40** fixed with respect to the internal parts of the propeller including the tube **22** and its ports. In this position the control valve **40** is in the null position which may be a center position in which it will completely block fluid flow to or from the propeller or may be a position off the center position by an amount sufficient to maintain hydraulic pressure in the high pitch chamber **34** sufficient to balance the propeller loads, and maintain the propeller blade angle in a fixed or given position.

For overspeed conditions the control system including the governor **114** will detect the overspeed, connect port **111** and pump outlet **107** with drain and unblock the pump **112**. The friction of gears **100** and **102** is sufficient to cause the gear **102** to rotate with respect to the gear **108** in a direction opposite to the propeller rotation. This motion transmitted through the low ratio gearing **98**, **100** and **102** will rotate the valve member **40** and the threads formed on the outside thereof in a direction to advance the member **40** toward the left or outboard end of the propeller. This movement of the control valve member **40** will admit hydraulic pressure fluid to the ports **72** and the high pitch chambers **34** and **50** and connect port **74** and low pitch chamber **32** with the drain line **70** which will move the cylinder **26** toward the right or inboard and thus move the blades to a higher pitch. The inboard motion of the cylinder **26** and the nut **94** occurs at the same rate as the lead of the screw threads **96**. The maximum forward displacement of the valve member **40** is limited to the valve opening required to move the cylinder **26** to the maximum high pitch blade rate. As the member **40** moves forward the clearance between the upstanding flange **116** and the bearing race **122** is reduced. This clearance is greater than the motion required to saturate the control valve in the high pitch direction. Therefore, as long as the hydraulic system operates normally the thrust bearing **120** will not interfere with the operation of the control system.

The motion of the blades towards increased pitch will decrease the propeller speed until the on speed condition is reached. The propeller control including the governor **114** will then stop the rotation of the input gear **102** with respect to the gear **106** and the blades will remain fixed as described for the on speed case.

During under speed condition the propeller control mechanism acts in the opposite sense to that described above for the over speed case and reduces the propeller pitch. The governor **114** will introduce oil under pressure from pump **115** into the pump mechanism **112** and pump outlet **107** and drive the pump as a motor so as to cause the gear **104** to drive the gear **102** faster than the rotation of the shaft **12** so as to move the valve member **40** inboard and connect the chambers **34** and **50** with the drain lines **70** and the chamber **32** with the pressure line **38**.

The axial motion of the valve member **40** required for normal propeller control is limited to the motion required to actuate the control valve to high pitch in one direction and to actuate the control valve to low pitch in the other direction. The clearance between the flange **116** and the thrust bearing race **122** and roller **120** is always maintained at a small value. This clearance represents a blade angle change of less than 1°. The blade reaction forces including the centrifugal twisting moments act in a direction to move the cylinder **26** in the low pitch direction and therefore the nut **94** and the valve member **40** and its flange **116** are always maintained in a position to lock the hydraulic pitch change mechanism in the event of a loss of hydraulic power. It should be noted that the nut **94**, the screw thread **96**, the valve member **40**, the flange **116** and the thrust bearing **120** represent a completely independent load path capable of supporting the blade loads and effectively lock the blade pitch. These elements are not subjected to fatigue loads and therefore represent an extremely reliable load path.

Normal feathering is accomplished in a conventional manner such as by biasing governor **114** to an overspeed condition by raising governor valve **121** manually by operation of the governor control **125** to move the valve member **40** to the left as explained in the overspeed condition and using the hydraulic pitch change system to continue operation of the increased pitch up to the feathered position. Feathering may also be accomplished by the mechanical system alone by first biasing the governor as in normal feathering and then actuating the mechanical pitch change mechanism. A loss of hydraulic power either accidentally or intentionally will bring the thrust face of the flange **116** into contact with the thrust bearing race **122** and thrust bearing **120**. The race **122** is driven through the gear reduction unit **128** by applying the brake **138** to the flange **136** as long as the propeller is windmilling or the shaft **12** is rotated. The power required to turn the flange **116** and increase the propeller pitch comes from the rotational energy of the propeller. The rotation of the race member **122** by rotation of the shaft **12** with the brake **138** applied will be in a direction to turn the valve member **40** and the screw threads **96** thereon in a direction to force the nut **94** and with it the cylinder **26** and the yoke **46** to the right and move the blades toward the feathered position. The travel of the nut **94** is sufficient to allow the blades to exceed the full feather position by a few degrees. At this angle the aerodynamic forces on the blade reverse and turn the propeller in the opposite direction or backwards. In this position the flange **116** is held in frictional engagement with the race **122** by the Belleville springs **140** so that reverse rotation and the springs **140** will bring the blades back toward the zero feather angle. Any further rotation of the propeller causes the blades to seek the aerodynamic zero feather angle. In order to prevent the feather system from overshooting the feather position by a large amount, a stop **142** is provided on the nut **94** for contact with the abutment **144** on the rotatable member **40**. As this stop is engaged, slippage must occur in the mechanical drive of the flange **116** and this occurs along the friction faces between the flange **116** and the bearing race **122**.

It is to be understood that the invention is not to be limited to the specific embodiments herein illustrated and described, but may be used in other ways without departure from the spirit and that various changes can be made which would come within the scope of the invention which is limited only by the appended claims.

We claim:

1. Pitch lock means for a controllable pitch propeller having blades, a blade supporting hub and a pitch changing motor connected to said blades, comprising a control member for said motor having a linearly movable portion, means, including a first connection and a second connection arranged in series and connecting said blades with said movable portion, said first connection including means transforming pitch changing movements of said blades into bodily linear movement of said second connection and said movable portion as a unit, said second connection including two relatively movable parts, means,

including pitch control mechanism, for relatively adjusting said parts for changing the relation of the blade pitch and the linear position of said movable portion, said movable portion having a neutral position fixed with respect to said hub and having a relatively small linear control movement to one side of said neutral position for controlling energization of said motor, positive mechanical stop means co-acting with said movable portion and blocking linear movement of said movable portion by said blades and thus blocking blade induced pitch change upon failure of said member to energize said motor within said relatively small control movement, and thus provide a pitch lock for said blades.

2. Pitch lock means as claimed in claim **1** in which said stop means is an abutment fixed with respect to said hub and located in the path of movement of said movable portion by said blades.

3. Pitch lock means as claimed in claim **1** in which the first connection is a form of cam and roller and the second connection is formed of mated helical or screw threaded members having an axis extending in the direction of said linear movement, one of said helical members being fixed with respect to said motor and said motor being fixed against rotation relative to said blade support.

4. Pitch lock means as claimed in claim **1** in which said stop means defines a limited position of said portion, and in which said means adjusting said connecting means changes the relation between the pitch of said blades and said stop limited position of said movable portion.

5. Pitch lock means as claimed in claim **4** in which said movable portion is mounted for linear movement along an axis by said blades and said second connection comprises a helical connection extending in the direction of said axis.

6. Pitch lock means as claimed in claim **1** in which said motor is a hydraulically actuated motor and said control member is a valve controlling the flow of fluid to said motor and having a portion fixed with respect to said hub cooperating with said movable portion.

7. Pitch lock means as claimed in claim **6** in which said valve movable portion is movable along an axis for control operation and is rotatable about said axis and said connecting means comprises a helical connection adjustable by rotation of said movable portion, said helical connection having one portion fixed with respect to said motor.

8. Propeller pitch changing mechanism for a propeller having blades and a blade support, comprising a pitch changing motor having a translatable part connected with said blades, control means for said motor including a control member, means connecting said member with said motor part including a threaded connection, said connection having one threaded portion fixed with respect to said motor part and the other threaded portion fixed with respect to said control member, said motor part translating said member bodily directly with translation of said part, said member being rotatable through said threaded connection with respect to and independent of said part, said threaded connection causing translation of said member relative to said part upon rotation of said member independent of part, said control means including an element fixed with respect to said blade support and cooperating with said control member and controlling the energization of said motor by translation of said member relative to said fixed element and forming with said member a follow up control actuated by said motor to deenergize said motor.

9. In a propeller as claimed in claim **8** in which the motor is hydraulically actuated and the control member is a portion of a valve connected with the motor by hydraulic lines and located in the blade support, means external of said support for moving said control member in said support to control energization of said motor.

10. A propeller as claimed in claim **8** in which the motor is hydraulically actuated and the translatable control member is a valve member forming a portion of a control valve, means for moving said valve member to control energization of said motor including first means for rotating said valve member and actuating said threaded connection to translate said valve member and other means for mechanically actuating said valve member including means for rotating said valve member and actuating said threaded connection for translating said valve member and means for limiting translating movement of said valve with respect to said blade support so that rotation of said valve member with respect to said motor part by said other means will mechanically move the propeller blades to change their pitch upon failure of said valve member to energize said motor.

11. Mechanism as claimed in claim **10** including governor controlled means actuating said first means for rotating said valve member.

12. Pitch changing means for a propeller having blades, means supporting said blades for pitch changing movement, and a pitch changing motor connected to said blades comprising a control member for said motor, means connecting said member with said blades and translating said member by pitch change of said blades, means changing the effective length of said connecting means and means holding said member against translation, and changing the blade pitch independent of pitch change by said motor by changing the effective length of said connecting means.

13. Pitch changing means for a propeller having blades, means supporting said blades for pitch changing movement, and a pitch changing motor connected to said blades, comprising a control member for said motor, means connecting said member with said blades and moving said member by pitch change of said blades, stop means limiting movement of said member by said blades, said connecting means including an adjustable connection operable to relatively move said blade pitch position and said member and means for operating said adjustable connection with said member positioned by said stop means to change the pitch of said blades.

14. Pitch changing means as claimed in claim **13** in which said member is threaded and said adjustable connection comprises a nut connected to said blades mating with threads on said member and said means for operating comprises means for rotating said member and threads relative to said nut.

15. Pitch changing means as claimed in claim **13** in which said stop means includes a first bearing race secured to said supporting means and a second bearing race cooperating with said first race and having a friction surface, a cooperating friction surface carried by said member and movable by said blades and member into engagement with said race friction surface and said means for operating comprises gear reduction means connecting said second race with means holding one end of the gear train of said gear reduction means against rotation while said propeller is rotating to rotate said second race and said member with respect to said nut and said supporting means.

16. In a controllable pitch propeller having blades and a pitch changing motor connected with said blades, a movable control member having a null position and an energizing position and controlling energization of said motor, means connecting said member with said blades returning said member to null position incident to movement of said blades by said motor, stop means in the path of movement of said member limiting movement of said member by said blades, means moving said member relative to said blades while in contact with said stop means and thereby moving said blades to change their pitch independent of said motor.

17. In combination, a hub and shaft rotatable as a unit, propeller blades supported by said hub for pitch

changing movement, a hydraulic motor connected with said blades for imparting pitch changing movement to said blades, means for introducing hydraulic fluid under pressure to said motor, means controlling the flow of hydraulic fluid to said motor comprising valve means having one portion fixed with respect to said hub and another portion movable with respect to said fixed portion and having a null position holding said motor stationary and a position to one side of said null position directing fluid to said motor, means, including mated helical members, mechanically connecting said movable valve portion with said motor for movement by said motor, means, including means rotating one helical member with respect to the other and moving said movable portion to said fluid directing position, said motor returning said movable portion to null position, mechanical stop means limiting movement with respect to said fixed portion and said hub, of said movable portion by said motor and additional means for rotating said one helical member with respect to the other upon failure of hydraulic pressure fluid to maintain said movable member against said stop means and utilize said helical members to mechanically move said motor and change the propeller pitch.

18. A propeller having a hub, blades supported by said hub for pitch changing movement, a pitch changing motor connected with said blades and means for energizing said motor including control means connected with said motor and controlling energization of said motor, means including a screw thread connection mechanically connecting said control means and said blades and means mechanically rotating said control means and utilizing said screw thread connection to mechanically change the propeller pitch upon failure of said motor.

19. A hub and a shaft rotatable as a unit, propeller blades supported by said hub, a hydraulic motor rotatable wtih said hub comprising a piston fixed with respect to said hub and a cylinder surrounding said piston and axially movable thereon, means connecting said cylinder with said blades for imparting pitch changing movement to said blades upon axial movement of said cylinder, means for introducing hydraulic fluid under pressure to said motor for energizing said motor for moving said cylinder in opposite axial directions, means controlling the flow of hydraulic fluid to and from said motor for controlling the energization thereof comprising valve means including one portion fixed with respect to said hub and another portion movable with respect to said fixed portion and having a null position for controlling fluid flow and holding said motor stationary and positions on either side of said null position for directing fluid to and energizing said motor and moving said motor in one direction or the other, means, including mated helical members, mechanically connecting said movable control portion with said movable cylinder of said motor for imparting movement of said cylinder and blades to said movable portion to restore said movable portion to its null position, means, including means rotating one helical member with respect to the other helical member for moving said movable portion with respect to said motor and blades to change the relation between the blade pitch and said null position, mechanical stop means, including a cooperating thrust bearing secured to said hub and a thrust flange secured to said movable portion mechanically limiting movement of said movable portion by centrifugal twisting moments of said blades throughout the propeller pitch range to substantially the distance from said null position to the fully open position of said movable portion, said movable portion operable in conjunction with said stop means to lock the propeller blades against pitch reduction upon failure of said motor or its controls, drive means for rotating said movable portion including a reduction gear connected with one portion of said thrust bearing and friction drive connection members including a frictional connection between said one bearing portion and said thrust flange and means holding one portion of said reduction gear against rotation while said shaft is rotating for rotating said movable portion, rotation of said movable portion rotating one helical member relative to the other helical member, movement of said movable portion limited by said stop means so that rotation of said movable member by said drive means will feather the propeller blades, and spring means assisting centrifugal twisting moments in holding said thrust flange against said thrust bearing and said friction drive connection members in frictional engagement.

20. In combination, in a controllable pitch propeller, propeller blades, a hydraulically actuated pitch changing motor operatively connected to said blades, control means for said motor operatively hydraulically connected to said motor, means mechanically connecting said control means to said blades, means actuating said control means to hydraulically actuate said motor, and other means actuating said control means including means manually applying force to said control means and through said control means manually applying force to said blades. to mechanically change the propeller pitch.

21. In a controllable pitch propeller as claimed in claim **16** spring means urging said member into contact with said stop means.

22. A combination as claimed in claim **17** in which said means for rotating said one helical member with respect to the other and moving said movable portion to said fluid directing position includes governor control means and said additional means for rotating said one helical member includes manually control means mechanically rotating said member.

23. A combination as claimed in claim **17** in which said mated helical members includes one member rotatably mounted with respect to the other member and the other member is fixed with respect to said motor.

24. In a controllable pitch propeller having blades and a blade supporting hub, a pitch changing motor connected to said blades including a motor having a part translatable with pitch changing movement of said blades and fixed against rotation with respect to said support, a translatable and rotatable control member for said motor carried by said hub and means mechanically connecting said motor part and blades with said rotatable control member for bodily translating said member with said motor part and rotatably connecting said motor part with said member for relative translation of said member and said motor part and blades by rotation of said member with respect to said motor part, governor controlled means rotating said member relative to said blade support to translate said member and energize said motor, other means rotating said member relative to said blade support including means holding said member against translation with respect to said support while rotating said member and thereby translating said motor part and changing the pitch of said blades.

25. Apparatus for translating a device intended to be translated and support therefor, an actuator having a translatable part connected with said device, control means for said actuator including a control member, means connecting said control member with said actuator part including a threaded connection, said connection having one threaded portion fixed with respect to said actuator part and the other threaded portion fixed with respect to said control member, said actuator part translating said member bodily directly with translation of said actuator part, said control member being rotatable through said threaded connection with respect to and independent of said part, said threaded connection causing translation of said control member relative to said part upon rotation of said member independent of said actuator part, said control means including an element fixed with respect to said support and cooperating with said control member and controlling the energization of said actuator by translation of said control member relative to said fixed ele-

ment and forming with said control member a follow-up control actuated by said actuator to position said actuator.

26. A hydraulically energized actuator having a member moveable rectilinearly characterized by being held stationary upon the loss of hydraulic fluid, hydraulic means including control means for urging said member rectilinearly, said control means including a rotatable element, a threaded element attached to said member and threadably engaging said rotatable element, said rotatable element moveable with and independently of said member, a control valve normally in a null position moveable to apply hydraulic fluid to and from said member for hydraulically moving said member rectilinearly, feedback means interconnecting said member and control valve for returning said control valve to the null position, the threads

of said rotatable element and said threaded element having sufficient friction therebetween to prevent relative rotation upon the application of force on said member.

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