

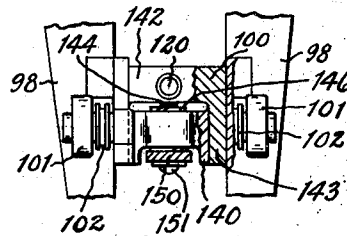
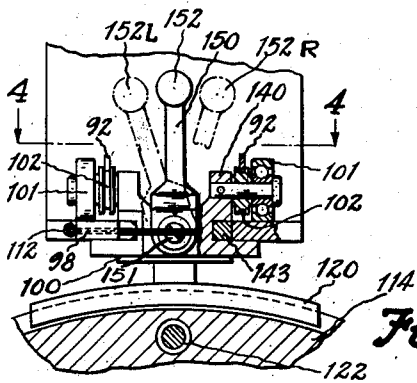
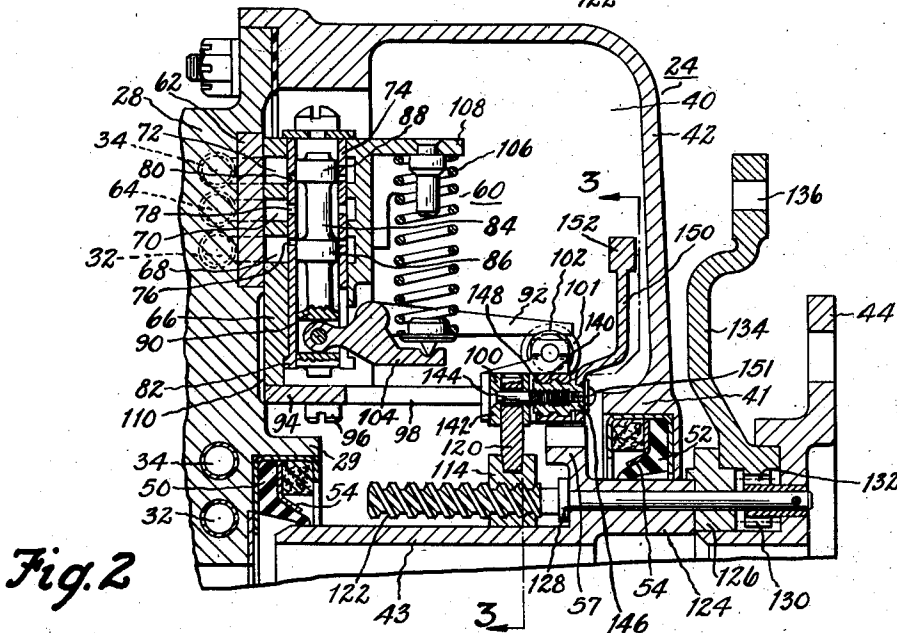
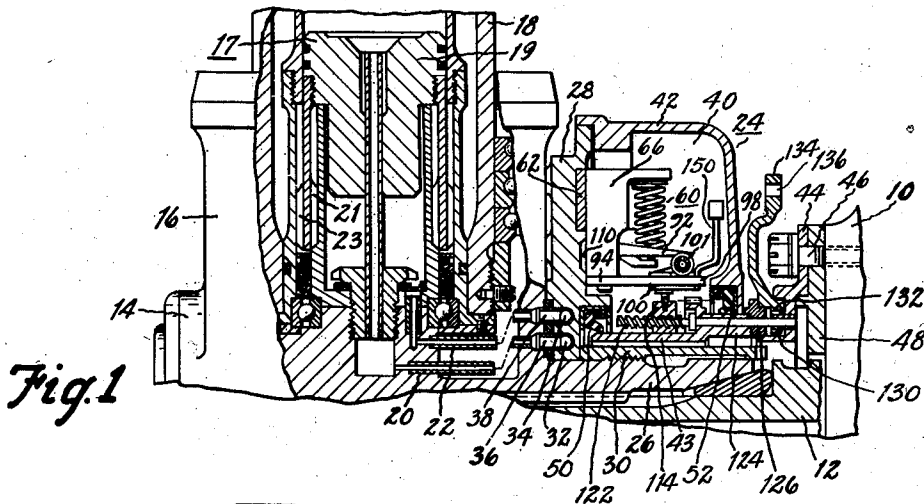
May 8, 1945.

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2,375,429

GOVERNOR MECHANISM

Filed Sept. 2, 1942



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2,375,429

GOVERNOR MECHANISM

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Application September 2, 1942, Serial No. 457,062

12 Claims. (Cl. 170—163)

This invention relates to regulators for fluid actuated controllable pitch propellers, and has for an object to provide means for regulating an operating propeller in response to acceleration or change of speed of the propeller.

A further object is to provide means in conjunction with a constant speed propeller for effecting regulation in response to a spurt or lag of controlled speed.

A still further object of the invention is to provide means and mechanism for controlling the shift of propeller pitch for constant speed operation, and then superpose control means upon the constant speed effected for finely adjusting the resulting speed.

Yet another object is to provide means responding to angular acceleration of the propeller shaft for anticipating a speed change before it actually occurs to any great extent and for applying the anticipated speed change to correction of blade pitch.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a fragmentary view in section with parts shown in elevation and illustrating an adaptation of the instant invention.

Fig. 2 is a view of part thereof but on a much enlarged scale.

Fig. 3 is a detail view in section with parts shown in elevation substantially as indicated by the line and arrows 3—3 of Fig. 2.

Fig. 4 is a detail view in top plan with parts shown in section substantially as indicated by the line and arrows 4—4 of Fig. 3.

In controllable pitch propellers that involve the use of a governor mechanism for the control of the blade pitch to a constant speed it is necessary that there be a change in speed before there can be any consequential change in blade pitch. As a result there is frequently a hunting of the control mechanism and some lag in its operation before the corrected impulse is fully effected. It is desirable to call up the regulation that is to be effected at the very earliest possible deviation from the selected speed for which regulation is to be made. In the case of those structures where the regulator mechanism involves a reservoir rotating with the propeller and housing the control mechanism, especially the governing valve mechanism, there is possibility of incorporating a control mechanism for the reregulation of the conventional control means. In the present instance, use is made of a pendulum situated within the reservoir that rotates with the regulator mechanism and is so pivoted that it will respond to angular acceleration or speed

changes of the propeller mechanism and effect a correcting influence upon the control valve. During a condition of constant speed operation the pendulum will occupy a radial position, but if there is angular acceleration then inertia of the pendulum causes it to advance or lag, as the case may be, and through the operation of a high lead screw adjust the control valve accordingly.

Referring particularly to the drawing, 10 indicates an engine casing from which extends a drive-shaft 12 for driving a propeller hub 14 providing a plurality of blade sockets 16. In the blade sockets torque applying units 17 are situated and have operative connections with the roots of blades 18 for twisting them about their longitudinal axes in response to fluid pressure applied to one or the other of the transfer tubes 20, 22 and to relief through the other. The direction of the torque applied to the blades is determined by which of the tubes 20, 22 the pressure is applied to, which in turn is determined by the operation of a regulator mechanism 24 mounted on and rotatable with the propeller.

Pressure applied to tube 20 is admitted to one side of the piston 19 of the torque applying unit and due to the double spiral spline engagement 21 on 23 causes rotation of the blade in one direction, while pressure applied to the opposite side of the piston 19 causes rotation of the blade in the opposite direction.

For mounting of the regulator the hub 14 is extended rearwardly along the shaft 12 to provide a sleeve 26 on which is piloted a regulator plate 28 as shown in detail in Fig. 1. The plate is of annular form and seats against the aft side of each of the blade sockets 16 where it is held by means of a sleeve nut 30 threaded onto the sleeve extension 26 of the hub. Fluid passages comprising tubular inserts 32 and 34 and perhaps others, are embedded in the body of the plate and are so arranged as to join up with transfer passages 36 and 38 respectively communicating with the tubes 20, 22 when the regulator plate is moved into position against the blade sockets.

The regulator plate 28 forms a mounting plate for the various elements of the control apparatus, later to be described, and also forms part of the enclosing means for a reservoir 40 which is completed by means of a cover member 42 fixed to and rotatable with the plate 28, and a relatively nonrotatable sleeve 43 inwardly disposed and held against rotation with respect to the engine casing by means of a mounting ring 44 and screw devices 46. An end plate 48 may be inserted therebetween for proper spacing and closing of the engine casing. Since the inner portions 29 and 41 of the plate 28 and cover 42 meet the sleeve 43 in rotative engagement they are each provided with oil seals 50, 52 that aid in minimizing leakage of a fluid medium from the reservoir 40.

Both of the oil seals are alike in construction and each have a spring member 54 backing them that yields sufficiently while under a state of rotation to lighten the pressure of the seals 50, 52 upon the sleeve 43, but during a state of rest press the seal members against the sleeve more firmly to stop leakage of the fluid medium.

The reservoir 40 so constructed by the elements 28 and 42 rotating with the hub 16 about the relatively fixed sleeve 43 is adapted to receive and retain a measured quantity of fluid pressure medium which for the most part substantially immerses the control mechanism. It is intended that the regulator mechanism shall be self-contained in all of its fluid circuits and parts to the inclusion of pressure developing means and pressure distributing means 60. The pressure developing means, such as a constant delivery pump may be driven from a toothed flange 57 extending from the fixed sleeve 43. The plate 28 provides definite stations on the inside of the reservoir where the various control elements shall be mounted, and is usually accomplished by incorporating mounting pads or juncture blocks making proper connection with the embedded tubes or passages so that mere mounting of the particular elements of the control mechanism in their designed places will automatically connect them into the fluid circuit at the proper point.

One such station is indicated by the pad 62 shown in the drawing and to which a pressure supply tube 64 and the control passages 32, 34 are joined so as to be accessible to the pressure distributing means 60. The particular form of pressure distributing means illustrated constitutes a governor valve mechanism of unitary construction whose movable valve parts provide centrifugally responsive elements opposed by spring pressure for controlling the propeller mechanism to operate at a substantially constant speed to be selected by hand from a point outside of the regulator.

Toward that end the governor valve mechanism includes a block 66 chambered at 68, 70 and 72 for fluid connection with the earlier mentioned pressure tubes and control passages. Secured within a bore of the block intersecting the chambers is a sleeve or liner 74 that has groups of holes 76, 78, 80 that open from the interior of the sleeve into each of said chambers. One end of the sleeve is headed or otherwise provided with stop means 82 for holding the sleeve properly positioned in the block, and a cross pin may be added at the other end for the same purpose. A valve plunger 84 is adapted to slide along the bore of the sleeve 74 and has a pair of spaced lands 86, 88 so positioned as to substantially stop flow through all of the ports of the groups 76 and 80 respectively when the valve plunger is in the equilibrium or mid position.

An extension of the plunger 84 provides a portion 90 to which is pivoted a lever 92 through which the valve actuating force is applied. A guide plate 94 is fixed at one end to an end of the block 66 by means of screws 96 and has a pair of guide arms 98 extending away from the block to slidably support a carriage 100. To reduce resistance of sliding movement the carrier 100 is provided with rollers 101 that roll upon the ways 98. A fulcrum roller 102 is carried by the carriage 100 and is adapted to support the extended or free end of the lever 92. A convenient form of the lever 92 is that of a yoke having two such arms in parallel each resting on a fulcrum roller and providing between them at the bite a

ledge or saddle 104 on which seats a spring 106. A rigid lug or other extension 108 at the opposite end of the block provides a rest for the seating of said spring at the other end and provides a rigid point from which the spring force may be applied in opposition to centrifugal force applied on the valve body when the regulator is rotating.

The governor valve mechanism so constituted is adapted to be mounted with its machined face 110 directly over the mounting pad or juncture block 62 so that the chambers 68, 70, 72 make fluid connection with ports or passages in the juncture block leading to the supply passage and control passages, and with the lever 92 at the in-board end of a radius of rotation. When so mounted the movable parts of the mechanism, that is the valve plunger 84 and the lever 92 form weight members responding to the action of centrifugal force in a manner tending to compress the constantly acting spring 106. Under a condition of rest the valve plunger will be projected radially inward so as to move the plunger to an "in" position in which the pressure ports 78 will be open to the pitch decreasing side of the torque applying unit through the chamber 68. That is because there is no centrifugal force applicable upon the movable elements of the valve mechanism and the spring force is dominant.

Starting of the engine results in rotation of the propeller with its attached regulator mechanism which rotation increases until the centrifugal force acting upon the movable elements of the valve mechanism balances the opposing spring force, at which time the valve plunger occupies an equilibrium position in which fluid flow is substantially stopped through either of the control ports 76 or 80. The propeller mechanism will then operate at a substantially constant speed until a different speed level is selected. Slight domination of either centrifugal force or spring force will shift the valve plunger 84 outward or inward respectively from the equilibrium position and result in a consequential application of fluid pressure from the supply port 78 either to the port 80 for pitch increase application or to the port 76 for pitch decrease application. The pitch change effected thereby will be reflected in the corrected speed of propeller rotation, to the extent that a pitch increase application will increase the load upon the engine to reduce its speed and the accompanying centrifugal force, by which the valve plunger regains its equilibrium position. Similarly, a pitch decrease lessens the load and is followed by an increase of engine speed and centrifugal force to bring the valve plunger back to the equilibrium position.

Selection of the different speed levels is accomplished by moving the fulcrum 102 relatively nearer to or further away from the point of applied spring force opposing the centrifugal force. Upon reference to Fig. 2, it will be noted that moving the fulcrum forward toward the valve plunger operates to shorten the length of the lever arms through which the opposing forces are applied to the valve plunger 84. However, the length of the arm between the fulcrum and the spring seat is shortened more rapidly and in greater proportion than is the length of the arm between the fulcrum and the pivot of the lever 92 with the valve extension 90. Thus, by movement of the fulcrum, the relation of the moment arms through which the centrifugal force and the spring force act is also changed. As the fulcrum is moved forward toward the valve plunger, the centrifugal force gains in effectiveness over the

spring force. When those conditions obtain, then the mechanism will control at a lower constant speed than when the fulcrum is at a point near the aft end of the guideway. A cross-pin 112 through the end of the ways prevents the carriage 100 from disengaging the ways.

Movement of the fulcrum 102 is accomplished by means of a control ring 114 slidable axially of the sleeve 43 and retained against rotation relative thereto. The control ring 114 is grooved to slidably receive a shoe 120 extending from the carriage 100. Thus movement of the control ring fore and aft along the sleeve 43 carries with it the carriage 100 and results in movement of the fulcrum 102 toward or away from the point of spring force.

Making for selective movement of the control ring 114 there are a plurality of high lead screw shafts 122 threaded through the control ring and journaled in a thickened portion 124 of the sleeve 43. These screw shafts are circumferentially spaced around the sleeve 43 and also extend through the aft portion of the adapter assembly supporting the sleeve 43, including a guide-ring 126 disposed between the end of the sleeve 43 and the mounting ring 44. A thrust collar 128 and a pinion 130 limit endwise movement of each screw shaft, and the pinion 130 engages a ring gear 132 mounted for oscillation in the space between the guide ring 126 and the mounting ring 44. The ring gear 132 is provided with a lug 134 apertured at 136 for linked or cabled connection with a manual or instrument control located in the pilot's compartment, or elsewhere, and completes the hookup for outside control of the parts situated within the reservoir 40. By oscillation of the ring gear the control mechanism may be set at a new speed level while the propeller is rotating, thereby superimposing manual control upon the automatic control at all times. As the ring gear is moved in one direction it rotates the screw shafts due to the geared engagement with the pinions 130, and the screw shafts in turn move the control ring along the sleeve 43 with a resultant movement of the carriage 100 which carries the fulcrum toward or away from the point of spring pressure.

The regulating of speed change anticipating mechanism comprehends manufacture of the carriage in two cooperable and relatively shiftable parts, one, 140 supporting the fulcrum rollers 102 and the antifriction rollers 101, and the other, 142 shiftable with respect to the part 140 and supporting the shoe 120. The part 142 has slidable engagement by rails 143 with the part 140 but is restrained from separation by means of a screw 144 and double pitch nut 146. The screw 144 is anchored in the part 142 and receives on its threaded end the nut 146 which has on its exterior surface a coarse pitch thread 148 engaging the part 140. The nut 146 extends to the rear of the part 140 and there receives a pendulum 150 secured by a screw device 151, whose weight 152 extends generally radially outward from the axis of rotation.

The screw 144 being secured in the part 142 against rotation and cooperating with the double pitch nut affords a differential screw device or screw jack for shifting the carriage parts 140 and 142 relative to each other upon swinging of the pendulum 150 to either side of the medial position. With respect to Fig. 3, if the pendulum swings to one side, say to 152L as shown in the drawing, the fulcrum 102 will be moved in one direction along the ways 98 with respect to the

shoe 120. If the pendulum swings to the other side, say to 152R, then the fulcrum will be moved in the other direction. The consequential amount of movement for the fulcrum under the pendulum control is designedly small so that the control function will be inaugurated almost before there is an actual change of speed.

Considering, that manual movement of the member 134 determines the position of the shoe 120 with respect to the valve plunger 84, which with the pendulum in the mid-position defines the speed level at which control will be effected, then any oscillation of the pendulum 150 will move the fulcrum roller 102 fore or aft to alter slightly the relation of the centrifugal and spring force acting on the valve plunger. As the balance of forces between engine output and propeller absorption changes in such a way as to cause a decrease in speed the pendulum will tend to advance in angular position and thereby effect such shift of the fulcrum roller 102 as to give the spring force a slight advantage over the centrifugal force. The dominating spring force shifts the valve plunger inward a slight amount to connect the pressure port 70 with the control port 78 and thereby apply a pitch decreasing impulse to the torque applying unit of the blades. In like manner an unbalance of forces tending to cause an increase in propeller speed will result in domination of the centrifugal force which shifts the valve plunger 84 outward to apply a pitch increasing impulse to the torque applying units. Thus, the pitch of the propeller blades is shifted quickly in response to angular change in speed at the very earliest indication of change in propeller rotation. However as soon as the forces again balance, the propeller blades return to the original position.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a controllable pitch propeller, a reservoir rotatable therewith and charged with a quantity of pressure actuating fluid, fluid pressure actuated control mechanism enclosed within the reservoir and operable upon rotation of the propeller for effecting pitch shift of the blades thereof toward constant speed operation, said control mechanism comprising, a governor valve unit including centrifugally operated means for selectively distributing the control force, and means including a pendulum and screw acting upon said centrifugally operated means in response to angular acceleration of the propeller for shifting the valve in anticipation of change in propeller rotation.

2. In a controllable pitch propeller having a reservoir rotatable therewith and charged with a quantity of pressure actuating fluid, fluid pressure actuated control mechanism enclosed within the reservoir and operable upon rotation of the propeller for effecting pitch shift of the blades thereof toward constant speed operation, said control mechanism comprising, a governor mechanism with connections for effecting constant speed operation of said propeller, and including a valve member adapted for movement from an equilibrium position in response to dominating spring and opposing centrifugal force, means for predetermining and selecting the speed level at which the opposing forces will be in equilibrium, and means including an oscillatable

pendulum operable upon the predetermining means and responsive to angular acceleration of the propeller for biasing the valve member to a corrective position.

3. In a controllable pitch propeller having a reservoir rotatable therewith and charged with a quantity of pressure actuating fluid, fluid pressure actuated control mechanism enclosed within the reservoir and operable upon rotation of the propeller for effecting pitch shift of the blades thereof toward constant speed operation, said control mechanism comprising, a governor mechanism with connections for effecting constant speed operation of said propeller, and including a valve member adapted for movement from an equilibrium position in response to dominating spring and opposing centrifugal force, means for predetermining the speed level at which the opposing forces will be in equilibrium, including a movable fulcrum, a lever resting on the fulcrum and pivoted to the valve member, and a carriage for moving the fulcrum toward and away from the valve member, and means for applying slight movement to the fulcrum in response to angular acceleration of the propeller.

4. The combination set forth in claim 3, in which the carriage comprises a pair of relatively movable parts one of which carries the fulcrum, and a pendulum oscillatable in a plane parallel with the plane of rotation is adapted to move one part of the carriage with respect to the other for effecting the slight fulcrum movement.

5. The combination set forth in claim 3, in which the carriage comprises a pair of relatively movable parts one of which carries the fulcrum, a differential screw connecting the carriage parts and adapted on rotation to move one of the carriage parts relative to the other, and a pendulum for turning the differential screw upon change of speed of the propeller whereby the said slight fulcrum shift is accomplished.

6. A hydraulically actuated controllable pitch propeller comprising in combination, torque applying units for changing the angle of attack of the blades of said propeller, a liquid containing reservoir mounted on the propeller, fluid pressure passages connecting the reservoir with the torque applying units, and pitch controlling means enclosed by the reservoir including governor mechanism for effecting constant speed regulation of said propeller within predetermined speed limits, said governor mechanism comprising a valve member adapted for radial movement in response to rotation of said propeller and opposed by spring force, a movable fulcrum, a lever bearing on the fulcrum for transmitting spring force to said valve member, means for moving the fulcrum to and from the valve member to vary the relation of the centrifugal and spring forces acting thereon for selecting a speed level at which regulation will be effected, and means operable upon the fulcrum to change its position automatically in response to angular acceleration of the propeller.

7. The combination set forth in claim 6, in which a divided carriage supports the fulcrum and is actuatable from outside the reservoir while the propeller is operating for the selecting of a speed level, and in which an inertia member operates to shift a part of the carriage and thereby the fulcrum position in said response to angular acceleration of the propeller mechanism.

8. In a constant speed propeller mechanism

having a hydraulic regulator rotatable with the propeller and containing control mechanism for effecting change in blade pitch in response to change in speed of propeller rotation, the combination comprising, a governor valve and lever pivotally connected therewith adapted for movement in a plane normal to the disc of propeller rotation, a ported housing locating the valve substantially on a radius of the disc of rotation, axial extensions from the housing disposed in spaced relation on either side of the lever, a fulcrum for the lever carried by one of the extensions, yielding means operating from the other of said extensions to bias said lever against movement by centrifugal force of propeller rotation, and means for shifting the fulcrum toward and away from the valve member in response to angular acceleration of said propeller.

9. The combination set forth in claim 8 wherein, a carriage supports the fulcrum and is constantly operable from outside the regulator for selecting a different speed level for which the propeller speed shall be controlled, said carriage being divided into two parts movable as a whole from outside of the regulator and one part thereof carrying the fulcrum and movable with respect to the other part by said acceleration responsive means within the regulator effecting said fulcrum shift in response to angular acceleration of said propeller.

10. The combination set forth in claim 8 wherein, a carriage supports the fulcrum and is divided into two parts, one movable with respect to the other, the whole carriage being movable at will from outside the regulator, and one part thereof being movable in relation to the other part by an inertia member within the regulator for effecting the said fulcrum shift responding to angular acceleration of the propeller.

11. In a rotatable hydraulic regulator of the class described, a governor valve unit rotatable with the regulator and comprising in combination, a ported housing extending radially of the axis of rotation, a pilot valve movable in the housing to cover and uncover the ports therein upon change in centrifugal force, a lever pivoted to the valve and extending from the housing, guide ways extending in spaced relation to the lever, a carriage movable along the guide ways and providing a fulcrum roller for supporting the extended end of said lever, means constantly biasing the lever against said fulcrum roller, rotation of the valve unit establishing a balance between centrifugal force thereof and the biasing means whereby the ports of the housing are covered by the pilot valve, means for setting the position of the carriage along the guide ways, and means responding to a rate of change in speed of rotation of said regulator for moving the fulcrum roller along the lever while the carriage is restrained in a set position.

12. The combination set forth in claim 11 wherein the means for moving the fulcrum roller relative to the carriage includes a threaded stud secured in one part of the carriage, a differential nut threaded onto the stud and into a movable part of the carriage, and wherein said means responding to a rate of change of speed includes an inertia member for turning the nut whereby shift of the valve member is made in anticipation of change in speed of rotation of said regulator.

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