Feb. 3, 1948. H. G. LEINER 2,435,360

VARIABLE PITCH PROPELLER

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Fig. 1.

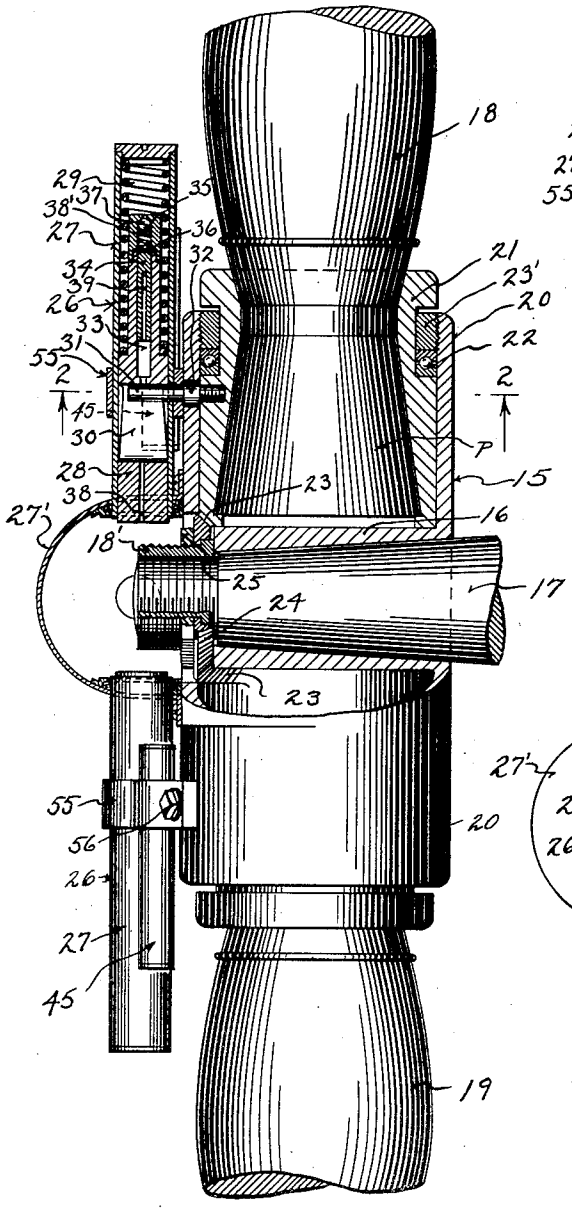


Fig. 2.

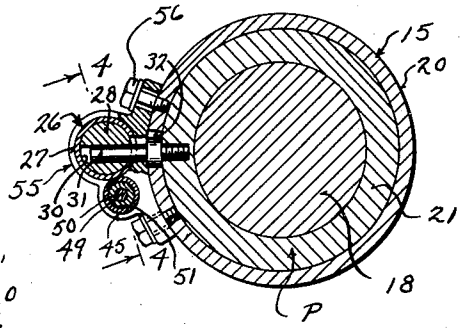
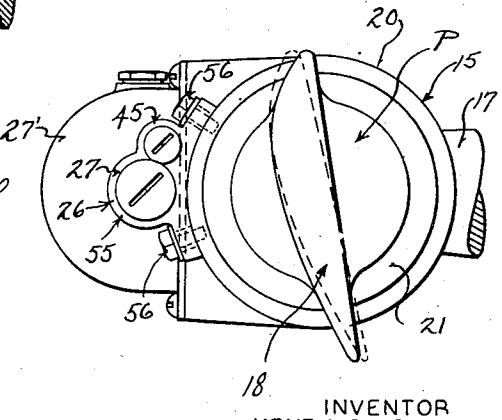


Fig. 3.



INVENTOR
HENRY G. LEINER

BY

ATTORNEYS

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Fig. 4.

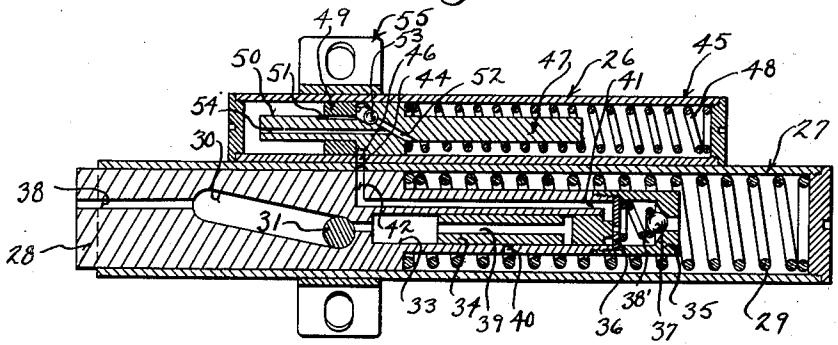


Fig. 5.

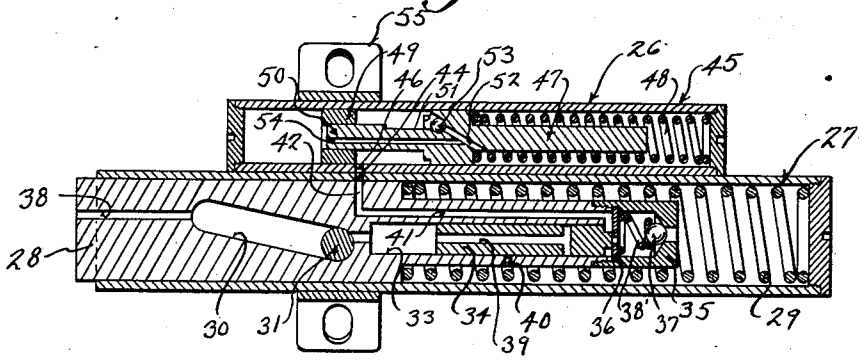
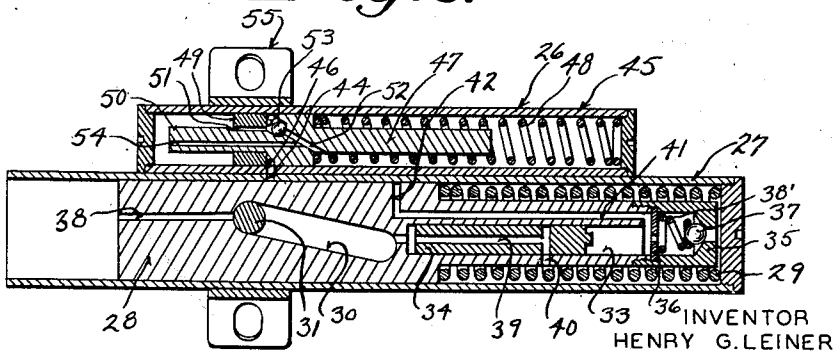


Fig. 6.



INVENTOR
HENRY G. LEINER

BY

ATTORNEYS

Feb. 3, 1948. H. G. LEINER 2,435,360

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Fig. 7.

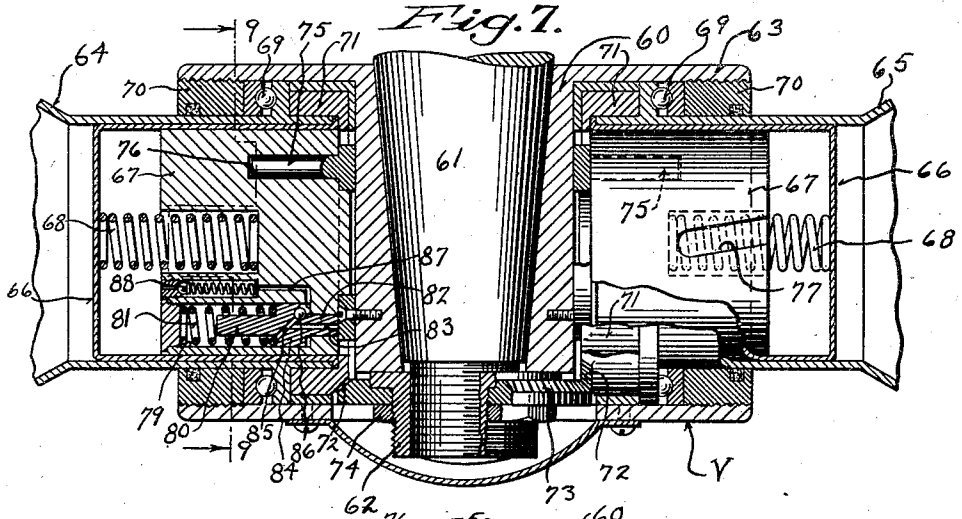


Fig. 8.

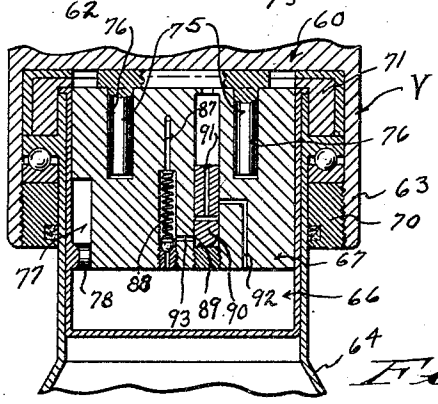


Fig. 9.

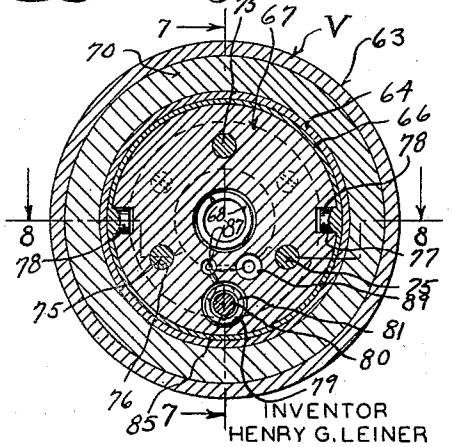
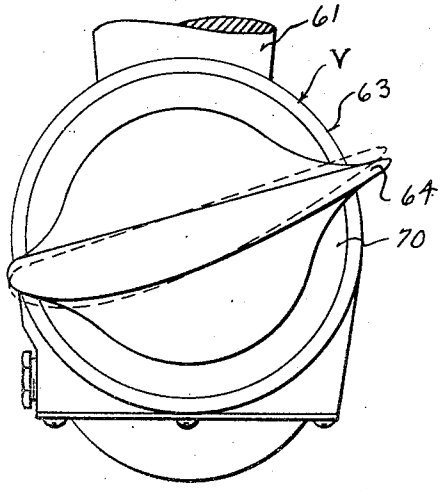


Fig. 10.



INVENTOR
HENRY G. LEINER

BY

ATTORNEYS

Patented Feb. 3, 1948 2,435,360

UNITED STATES PATENT OFFICE

2,435,360

VARIABLE PITCH PROPELLER

Henry G. Leiner, Racine, Wis., assignor of one-half to Virginia A. Leiner, Racine, Wis.

Application December 30, 1944, Serial No. 570,732

5 Claims. (Cl. 170—162)

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This invention appertains to air craft and more particularly to a novel airplane propeller.

One of the primary objects of my invention is to provide a fully automatic means for controlling the pitch of the propeller blades according to the speed (i. e. R. P. M.) of the propeller, whereby the propeller will function to the best of advantage for take-off, cruising, landing, etc.

Another salient object of my invention is to provide an airplane propeller having incorporated with the hub thereof an automatic means for controlling the pitch of the blades in accordance with the conditions of operation and flight; the construction being such that not only a strong and simple mechanism will be had, but one which can be purchased at a comparatively low cost thereby rendering the same particularly adaptable for use for small airplanes.

A further object of my invention is to provide a variable pitch propeller having the blades thereof mounted in the hub for turning movement, with means responsive to centrifugal force for turning the blades according to the speed of rotation of the propeller.

Another further object of my invention is to provide means for operatively connecting the blades together, whereby the turning action of the blades will be coordinated, so that the blades will always be at the same pitch relative to one another.

A still further object of my invention is to provide a variable pitch propeller which is fully automatic and which does not require any manual operation on the part of the pilot.

A still further important object of my invention is to provide a variable pitch propeller which can be used on an ordinary propeller shaft thereby eliminating the necessity of providing a propeller shaft of a special design, the propeller also functioning with an ordinary design of invention.

With these and other objects in view, the invention consists in the novel construction, arrangement, formation of parts as will be hereinafter more specifically described, claimed and illustrated in the accompanying drawings, in which drawings:

Figure 1 is a fragmentary side elevational view of my novel propeller with parts thereof broken away and in section to illustrate structural detail.

Figure 2 is a detail sectional view through the propeller taken substantially on the line 2—2 of Figure 1 looking in the direction of the arrows.

Figure 3 is an end elevational view of the propeller looking inwardly along one blade toward the hub.

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Figure 4 is an enlarged detail longitudinal sectional view through the control mechanism for one blade, the section being taken substantially on the line 4—4 of Figure 2, looking in the direction of the arrows, the parts of the control mechanism being shown in their position during the warming up of the engine.

Figure 5 is a view similar to Figure 4 but showing the parts in position during the increasing of speed of the engine for take-off.

Figure 6 is a view similar to Figures 4 and 5 but showing the parts in their position for increasing the pitch of the propeller.

Figure 7 is a diametric sectional view through the hub of a propeller showing a modified form of my invention with the controls incorporated in the stems of the propeller blades, the section being taken substantially on the line 7—7 of Figure 9, looking in the direction of the arrows.

Figure 8 is a detail sectional view through one of the blades and its control mechanism, the view being taken substantially on the line 8—8 of Figure 9, looking in the direction of the arrows.

Figure 9 is a sectional view taken on the line 9—9 of Figure 7 looking in the direction of the arrows.

Figure 10 is an end elevational view looking inwardly from the tip of one propeller blade toward the hub.

Referring to the drawings in detail, wherein similar reference characters designate corresponding parts throughout the several views, the letter "P" generally indicates my novel propeller and the same includes a propeller hub 15. This hub 15 includes the axially disposed tapered sleeve 16 for the propeller shaft 17. The hub is held on the shaft 17 by a nut 18' which is threaded tight on the shaft against the sleeve 17. In the present form of my invention the propeller includes two blades 18 and 19, and hence the hub 15 also includes diametrically extending sleeves 20 for the stems of the propeller blades.

In accordance with my invention the stems of the propeller blades 18 and 19 are imbedded in thimbles 21 which are rotatably mounted in the sleeves 20. A thrust bearing 22 is provided for each thimble and the thrust bearings and the thimbles with the propeller blades are held in the sleeves 15 by a split nut 23'. Thus from the description so far, it can be seen that the propeller blades are mounted for turning movement within the hub sleeves 20. To coordinate the turning action of the propeller blades, the inner ends of the thimbles have formed thereon sector gears 23 which mesh with a beveled gear 24 ro-

tatably mounted upon the hub nut 18'. A lock nut 25 can be threaded upon the hub nut 18' for holding the beveled gear 24 against displacement. Obviously turning movement of one blade will be transmitted to the other blade.

A controlling mechanism 26 is provided for each propeller blade and as the control mechanism for each blade is identical only one control mechanism will be described in detail. However, it is to be noted that the propeller hub has associated therewith a hub cap 27' which functions as an oil reservoir and the controls for the propeller blades have their inner ends projecting into and communicating with the interior of the hub cap. The control mechanisms extend radially from the hub cap and substantially parallel with the propeller blades.

Each control mechanism includes a master cylinder 27 having slidably mounted therein a combination weight and piston 28. This weight is normally held inwardly toward the axial center of the propeller by an expansion coil spring 29. It will be noted that the outer end of the weight is reduced in diameter to form a shoulder seat for the spring 29. The inner end of the weight is provided with a diagonally extending slot 30 into which projects the control pin 31 for a propeller blade. The inner end of the control pin is securely anchored to the thimble of the adjacent propeller blade and the pin moves in its hub sleeve 20 through a short circumferentially extending slot 32. Obviously as the weight 28 moves outwardly under centrifugal force the walls of the diagonal slot 30 will move the pin 31 in the slot 32 for changing the angle or pitch of its propeller blade.

The combination weight and piston 28 has formed in its outer end a longitudinally extending chamber 33 in which is slidably mounted a piston valve 34. A valve casing 35 is threaded on the extreme outer end of the weight 28 and holds in place a valve disc 36, the valve opening in which is normally closed by the piston valve 34. A ball check valve 37 is mounted in the valve casing and is normally held on its seat by a light expansion spring 38'. Communicating with the inner end of the chamber 33 is a longitudinally extending bore 38 which opens into the reservoir or hub cap 27'.

The piston valve 34 itself is provided with a T-shaped passageway 39 and one branch of the T is adapted to register at certain times, with an opening 40 formed in the weight 28.

At one side of the chamber 33, the weight 28 has formed therein a longitudinally extending passageway 41 and one end of this passageway communicates with the outer end of the chamber 33. The inner end of the passageway 41 communicates with a radially extending bore 42 which is adapted to register with an opening 44 formed in the master cylinder, at certain times, as will be later set forth.

Arranged alongside of and parallel with the master cylinder 27 is an auxiliary cylinder 45. This cylinder has formed therein an opening 46 which is in alinement with the opening 44. Slidably mounted within the auxiliary cylinder 45 is a controlling weight 47 and this weight also moves outwardly under centrifugal force and controls the action of the large piston weight 28 as will also be hereinafter more fully pointed out. The control weight 47 is normally held inward against centrifugal action by an expansion coil spring 48. The outer end of the control weight is reduced in diameter to form a shoulder seat for the

spring. The inner end of the control weight is also reduced in diameter and is slidably mounted within a ring 49 firmly anchored to the walls of the cylinder 45 inward of the opening 46. One face of the reduced portion 50 of the control weight has formed therein a longitudinally extending groove 51, which establishes, at certain times, communication between the cylinder 45 on opposite sides of the guide ring 49. Formed in the control weight 47, intermediate its ends, is a diagonally extending passageway 52 which connects the opposite ends of the piston weight on opposite sides of the enlarged central portion of the control weight. Flow of fluid through this passageway is controlled by a ball check valve 53. The ball check valve 53 is normally held on its seat by centrifugal action. A longitudinally extending bore 54 connects the inner end of the control weight with the inclined passageway.

Obviously, the control mechanisms 26 can be secured in place on the propeller hub in any preferred manner, such as by the use of bracket straps 55.

The control mechanisms function as follows. Considering that the engine is idling or running at a warm-up speed, the parts of the control mechanism will be positioned as shown in Figure 4. The piston weight 28 and the control weight 47 are at the extreme inner ends of their cylinders and consequently the propeller blades are at their lowest pitch; it being understood that the centrifugal force acting against control weight 47 and piston weight 28 at low speed is insufficient to overcome the tension of the springs 29 and 48. In the warming up R. P. M., the piston valve 34 is moved outwardly under centrifugal force and closes opening 40 (see Figure 5). This prevents the escape of oil in the chamber at the outer end of the cylinder 27, in that the oil cannot flow from the outer end of the cylinder through opening 40 and through the T-shaped passageway 39 in the valve 34 to the inner end of the cylinder 27. Consequently, the trapped oil functions with the spring 29 to hold the main weight 28 at the inner end of the cylinder. It is well to note at this point that the reservoir 27' is filled with a suitable fluid such as oil or the like and that this fluid fills the various cylinders of the mechanisms through the passageway 38 formed in the main weight.

During take-off, the speed of the motor is increased until the propeller is rotating say 2500 R. P. M. The centrifugal force increases on piston weight 28 and control weight 47, tending to increase pitch of propeller. However, the chamber in the cylinder 27 is filled with oil which locks the piston weight 28 against outward movement and counteracts the tendency of the piston weight 28 to increase the pitch of the propeller. In this manner, the propeller is held in low pitch for take-off. The resultant high R. P. M. of the motor increases the power and increases take-off efficiency. During the take-off, centrifugal force acts upon the control weight 47 (see Figure 5) and moves it outwardly toward the tip of the propeller against the tension of the coil spring 48 pushing the oil in the outer end of the cylinder 45 to the inner end of the cylinder past the ball check valve 53.

During cruising, the throttle is pulled back to a cruising speed, say 2,000 R. P. M. and the propeller will go into cruising pitch (a calibrated pitch for R. P. M. or constant speed control) by the decrease of centrifugal force on the control weight 47, for the reason that as the centrifugal

force decreases on the control weight 47, the spring 48 will tend to move the control weight inwardly toward the axial center of the propeller and the oil in the inner end of the cylinder 45 will be forced from the inner end of the cylinder through openings 46 and 44 into the bore 42 and passageway 41. The check valve 53 will be held on its seat due to oil pressure. Thus the oil will be forced into the piston weight 28 and the oil pressure acting on valve piston 34 will move the valve piston inwardly and aline the T-shaped passageway 39 with the port or opening 40. This will release the oil located in the outer end of the main cylinder 27 allowing the centrifugal action to move piston weight 28 outwardly toward the tip of the propeller (see Figure 6). The outward movement of the piston weight 28 will transmit the desired rotary movement to the propeller blades and increase the pitch thereof. As the piston weight moves outwardly, bore 42 moves away from the opening 44 and the oil in the piston weight 28 is locked therein. This trapped oil keeps the valve piston 34 inward in the piston weight (as shown in Figure 6) and keeps the T-shaped passageway in communication with the opening 40, so that piston weight 28 can increase or decrease pitch of the propeller. This is accomplished by increase or decrease of R. P. M. in conjunction with the tension of the calibrated spring 29, giving the propeller constant speed performance.

The replacement of spring 29 by an equal spring calibrated for 1,000 R. P. M. will give my propeller low pitch for take-off and an increased pitch (high pitch) for cruising.

During landing or gliding, the throttle will be moved back toward a closed position and when the speed of the propeller drops under say 1,000 R. P. M., piston weight 28 will move inwardly to its normal position under influence of the spring 29 to the position shown in Figure 4, and the blades will be turned to their extreme low pitch. As the piston weight 28 moves inwardly in its cylinder toward the hub of the propeller the outer end of the cylinder 27 will again fill with oil due to the fact that oil will flow from the reservoir through the passageway 38, through the piston valve 34 into the outer end of the cylinder 27. Passageway 41 and bore 42 will again be in communication with opening 44 and the control is all ready for high R. P. M. and high horsepower in case of emergencies. The check valve 37 carried by piston weight 28 comes into play only when propeller is overspeeded, say over 2500 R. P. M. and this check valve constitutes an overspeed control.

Say that the plane is put into a dive in the take-off pitch and the speed of the motor is increased and the various parts of the control are in the position shown in Figure 4. If the speed of propeller, due to the dive, exceeds 2500 R. P. M., then the piston weight 28 tends to move outward increasing the pressure on the oil pressure in the outer end of the cylinder 27. The increased pressure of the oil will unseat the ball check valve 37 and the oil will slide back piston slide valve 34 to aline the T-shaped passageway with port 40 allowing the oil trapped in the outer end of cylinder 27 to escape through piston slide valve. Piston weight 28 can now move outwardly to increase fully the pitch of the propeller. This will result in decrease of R. P. M. to save the engine.

The R. P. M.'s mentioned in this specification are merely illustrative and the design can cover any desirable range of R. P. M.

Initially the low pitch on the propeller can be set or adjusted by moving the control mechanisms 26 circumferentially of the hub. This can be accomplished by loosening the screws 56 utilized for holding the brackets 55 in place and after the control mechanisms have been moved the screws 56 can again be tightened. Obviously I do not limit myself to the use of brackets in that ears or the like can be formed directly on the cylinders of the control mechanism. The high pitch of the propeller can be controlled by the length of travel of the pins 31 in the slots 30.

In Figures 1 to 6, inclusive, my control mechanism has been shown built exteriorly of the propeller hub but obviously the controls can be incorporated in a hollow blade propeller with the mechanism working inside of the blades. Such a construction is shown in Figures 7 to 10, inclusive.

This propeller is generally indicated by the reference character "V" and the same includes an axial hub sleeve 60 for the reception of the propeller shaft 61. A nut 62 is employed for holding the hub on the shaft. Also formed on the hub sleeve 60 are radially extending blade sleeves or sockets 63 for the stems of the propeller blades 64 and 65, which are of the hollow type. The stems or roots of the blades 65 have pressed therein cylinders 66 for the reception of sliding piston weights 67. Expansion springs 68 of a pre-determined tension are utilized for normally holding the piston weights against the action of centrifugal force in the inner ends of the cylinders toward the propeller shaft. These blades are mounted for turning movement in the sockets 63 and thrust bearings 69 are utilized for the blades. Nuts 70 are threaded into the sockets for holding the blades against displacement. Also secured to the inner ends of the stems of the blades are collars 71 and these collars have formed thereon sector gears 72 which mesh at all times with a beveled gear 73 rotatably mounted upon the shaft nut 62. Lock nut 74 can be threaded on the shaft nut for holding the gear 73 in place. This gear meshing with the sector gears 72 functions to coordinate the turning of the propeller blades.

To insure straight outward movement of the piston weights, guide pins 75 are carried by the hub sleeve 70 and these pins are received in suitable guide openings 76 formed in the piston weights. These piston weights 67 have formed therein inclined grooves 77 and these grooves receive pins 78 formed on or carried by the stems of the propeller blades. Consequently when the piston weights 67 move outwardly against the tension of their springs 68, a turning movement will be imparted to the blades through the pins for changing the angle or pitch of the propeller blades.

Formed within each piston weight 67 is a cylder 79 and slidably mounted in each cylinder is a control weight 80. Each weight 80 has its outer end reduced in diameter to form a shoulder seat against which is fitted an expansion coil spring 81. The spring functions to normally hold the control weight inwardly against the action of centrifugal force. Formed on the inner end of each control weight is a reduced guide stem 82 and this stem is provided with a longitudinally extending passageway 83 which opens into the inner end of the cylinder 66. The formation of the stem 82 and the reduced portion of the control weight provides a central body portion 84 and this body portion is provided with a diagonally extending

way 85 which connects the ends of the cylinder 79 together on opposite sides of the body portion 84. A check valve 86 normally closes this passageway and centrifugal force tends to hold the ball check valve 86 on its seat. Each piston weight also has formed therein a passageway 87 which communicates with the inner end of the cylinder 79 and the outer end of the main cylinder 66. A spring pressed check valve 88 normally closes this passageway.

Also formed in each piston weight 67 is a chamber 89 in which is slidably mounted a slide piston valve 90. The inner end of the guide way 89 communicates with the inner end of its main cylinder 66. The slide piston valve 90 has formed therein a T-shaped passageway 91 and this passageway opens out to the inner end of the slide piston valve and is adapted to communicate at certain times with a passageway 92 formed in the piston weight 67. This passageway 92 also opens out through the outer end of the piston weight 67 and consequently communicates with the outer end of the cylinder 66. A port 93 is employed for connecting the passageway 87 inwardly of the ball check valve 88 with the chamber 89.

The control mechanisms in Figures 7 to 10, inclusive, function in identically the same manner as the control mechanism shown in Figures 1 to 6, inclusive. Hence, when the engine is warming up the various parts of the mechanism will be positioned as shown in Figures 7, 8 and 9. The piston slide valve 90 moves outward toward the tip of the propeller due to centrifugal force as shown in Figure 8 and the passageway 92 will be closed locking the oil in the outer end of the cylinder 66. As the R. P. M. increase for take-off, centrifugal force also increases on the piston weight 67 tending to increase the pitch of the propeller. However, as the oil is trapped in the outer end of the cylinder this tendency is counteracted. In this manner the blades are held in low pitch for take-off. The resultant high R. P. M. of the motor increases the horsepower and increases take-off efficiency. During the take-off, the centrifugal force acts upon control weight 80 and moves it outwardly toward the tip of the propeller and the oil in the outer end of the chamber 79 will be transferred through inclined passageway 85 past the ball check valve 86 to the inner end of this chamber.

When throttle is pulled back to cruising speed (2,000 R. P. M.) the propeller will go into cruising pitch (a calibrated pitch for the R. P. M. or constant speed control) by the decrease of centrifugal force on control weight 80. Spring 81 will return the control weight to the inner end of the chamber forcing the oil in the inner end of the chamber into passageway 87 and this oil will force back slide piston valve 90 and aline the T-shaped passageway 91 with the passageway 92. This will permit the flow of the trapped oil from the outer end of the cylinder 66 to the inner end of the cylinder and the piston weight 67 will move outwardly increasing the pitch of the propeller. As soon as the R. P. M. decreases below a certain point for gliding or landing the parts of the mechanism will return to their normal positions.

If the propeller is overspeeded in diving, the pressure will be sufficient to unseat ball check valve 88 and escape of oil into the chamber 89 will operate slide piston valve 90 to aline the T-shaped passageway 91 with the passageway 92 so that the weight 67 can move outwardly to increase the pitch of the propeller to its fullest extent.

From the foregoing description it can be seen that I have provided an exceptionally simple and durable form of control mechanism which can be incorporated with a propeller at an extremely low cost.

Changes in details may be made without departing from the spirit or the scope of my invention, but what I claim as new is:

1. In a variable pitch propeller, a hub, blades mounted in said hub for turning movement, means coupling said blades together for coordinating the turning movement thereof, a control mechanism for turning the blades according to the speed of the propeller including a cylinder, a piston weight slidably mounted in the cylinder, means operatively connecting the weight with a blade for turning said blade during sliding movement of the weight spring means normally holding the weight against outward movement, said cylinder being filled with a liquid, and means sensitive to centrifugal action for releasing fluid from one end of the cylinder to the other according to the speed of rotation of the propeller, said piston weight also having a port therethrough and a spring pressed check valve for controlling the flow of fluid therethrough, said spring pressed check valve being operable when the speed of the propeller exceeds a normal take-off speed.

2. In a variable pitch propeller, a hub, propeller blades mounted in the hub for turning movement, a cylinder arranged radially of the hub, a piston weight slidably mounted in said cylinder and movable outwardly under centrifugal force, means for turning the propeller blades from said piston weight upon sliding movement thereof, spring means normally holding the piston weight at the inner end of the cylinder, said cylinder having a liquid therein for preventing outward movement of the piston weight under the influence of centrifugal force, a second cylinder arranged radially of the hub, a control weight slidably mounted in said second cylinder and movable under the action of centrifugal force, and means operated by movement of said control weight for permitting the escape of liquid from the outer end of the first cylinder to permit outward movement of the piston weight, and said piston weight having a passageway therethrough and a spring pressed check valve for controlling the flow of liquid through said passageway and movable to an unseated position when the pressure of liquid in the outer end of the cylinder exceeds a pre-determined degree.

3. In a variable pitch propeller, a hub, blades mounted for turning movement in the hub for varying the pitch thereof, a control mechanism for regulating the pitch of the blades including a main cylinder and an auxliliary cylinder, said cylinders being arranged radially of the hub, a sliding piston weight in the main cylinder movable outwardly under centrifugal force having a diagonal slot therein, a rigid pin carried by a blade received in said slot whereby upon radial movement of the piston weight the blade will be turned, spring means normally holding the piston weight at the inner end of the cylinder, said cylinder having a liquid therein for resisting outward movement of the piston weight under centrifugal force, a control weight slidably mounted in the auxiliary cylinder, and means including a slide valve for releasing trapped liquid in the cylinder by movement of said control weight so that the piston weight can function under centrifugal force when the propeller

reaches a certain number of R. P. M., said auxiliary cylinder having liquid therein, means including a check valve for permitting the transfer of liquid from one side of the auxiliary cylinder to the other according to the position of the control weight under the action of centrifugal force to force oil against said slide valve, said slide valve functioning to cover and uncover ports for permitting communication of the outer end of the main cylinder with the inner end thereof.

4. In a variable pitch propeller, a hub, blades mounted for turning movement in the hub for varying the pitch thereof, a control mechanism for regulating the pitch of the blades including a main cylinder and an auxiliary cylinder, said cylinders being arranged radially of the hub, a sliding piston weight in the main cylinder movable outwardly under centrifugal force having a diagonal slot therein, a rigid pin carried by a blade received in said slot whereby upon radial movement of the piston weight the blade will be turned, spring means normally holding the piston weight at the inner end of the cylinder, said cylinder having a liquid therein for resisting outward movement of the piston weight under centrifugal force, a control weight slidably mounted in the auxiliary cylinder and movable outwardly under centrifugal force, and means including a slide valve for releasing trapped liquid in the cylinder by movement of said control weight so that the piston weight can function under centrifugal force when the propeller reaches a certain number of R. P. M., said auxiliary cylinder having liquid therein, means including a check valve for permitting the transfer of liquid from one side of the auxiliary cylinder to the other according to the position of the control weight under the action of centrifugal force to force oil against said slide valve, said slide valve functioning to cover and uncover ports for permitting communication of the outer end of the main cylinder with the inner end thereof, said piston weight also having an additional passageway therein and a check valve for controlling the flow of liquid through said additional passageway only when the pressure on the liquid in the outer end of the main cylinder exceeds a pre-determined amount.

5. In a variable pitch propeller, a hub, propeller blades having hollow stems, means rotatably mounting said stems in the hub whereby the pitch of the blades can be changed, cylinders carried by the hollow stems, sliding piston weights slidably mounted in the cylinders, means operatively connecting the piston weights with the stems of the blades for turning said blades upon sliding movement of the piston weights in the cylinders, spring means normally holding the weights inwardly toward the axis of the hub, said cylinders being filled with liquid for resisting outward movement of the weights under centrifugal force, and means sensitive to centrifugal force for allowing the escape of liquid from the outer ends of the cylinders when the propeller reaches a pre-determined number of R. P. M. including a slide valve carried by each piston weight sensitive to centrifugal force for controlling the flow of fluid through the piston weights, said piston weights also having an independent passageway therethrough connected with the outer end of the chamber for the slide valve, and a spring pressed check valve for controlling the flow of fluid through the passageway and to the outer end of the chamber of the slide valve operable when the speed of the propeller exceeds a normal take-off speed.

HENRY G. LEINER.

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