

Nov. 28, 1944.

W. S. HOOVER

2,363,670

VARIABLE PITCH CONSTANT SPEED PROPELLER ASSEMBLY

Filed Aug. 22, 1940

4 Sheets-Sheet 1

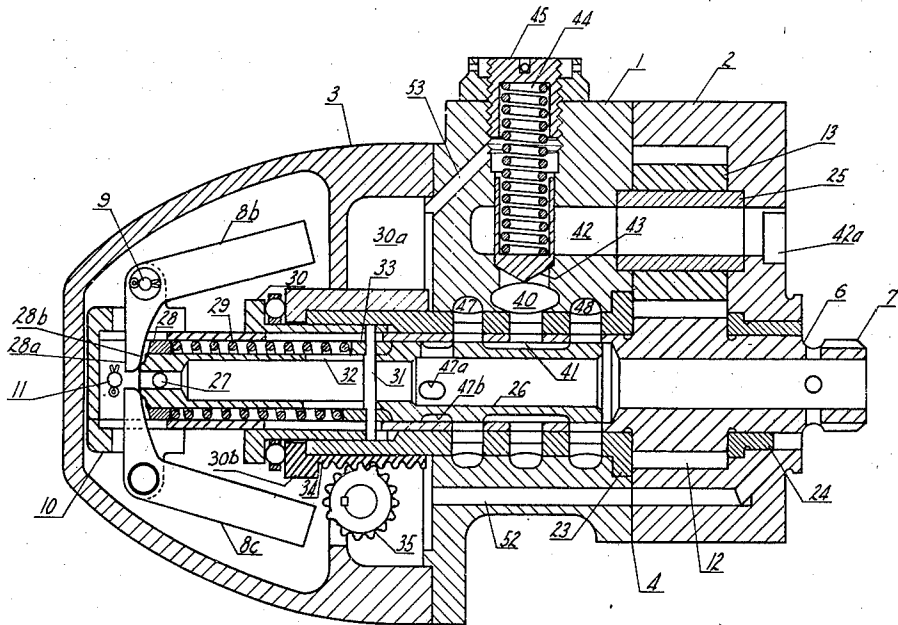


Fig. 1

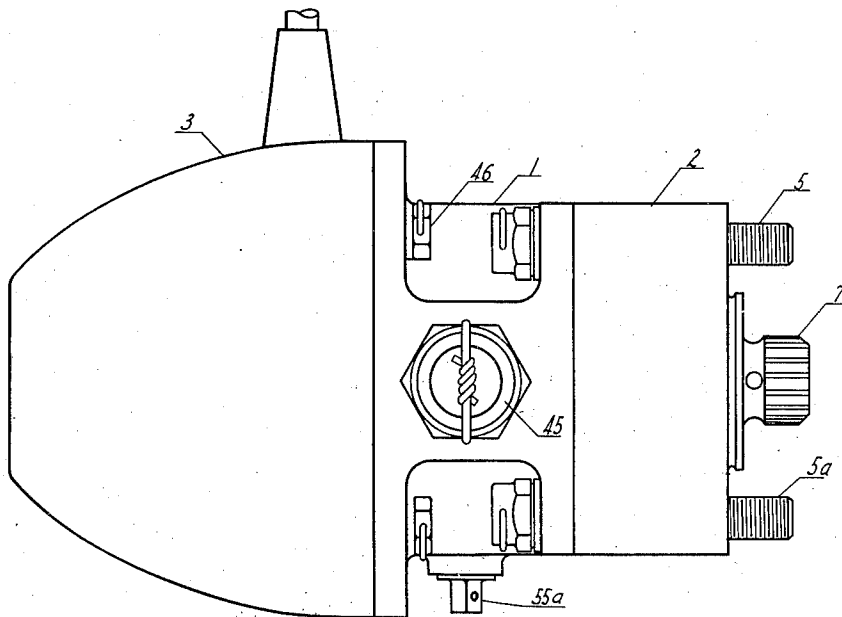


Fig. 2

INVENTOR.
Walter S. Hoover
BY William B. Gaspert
Attorney.

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W. S. HOOVER

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4 Sheets-Sheet 2

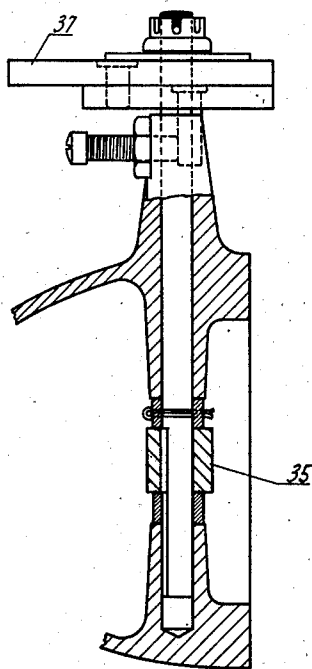


Fig. 4

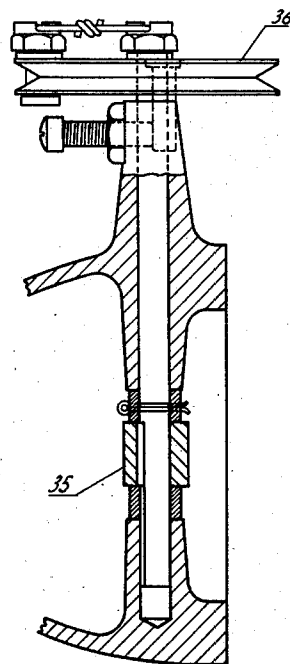


Fig. 5

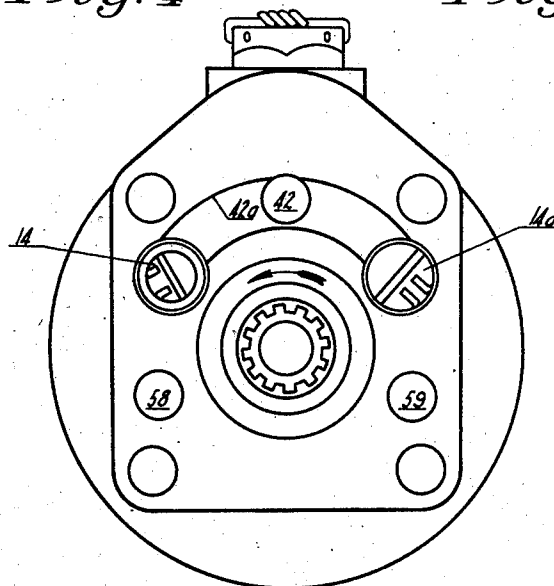


Fig. 3

BY

INVENTOR.

Walter S. Hoover

William B. Jaspert
Attorney.

Nov. 28, 1944.

W. S. HOOVER

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4 Sheets-Sheet 3

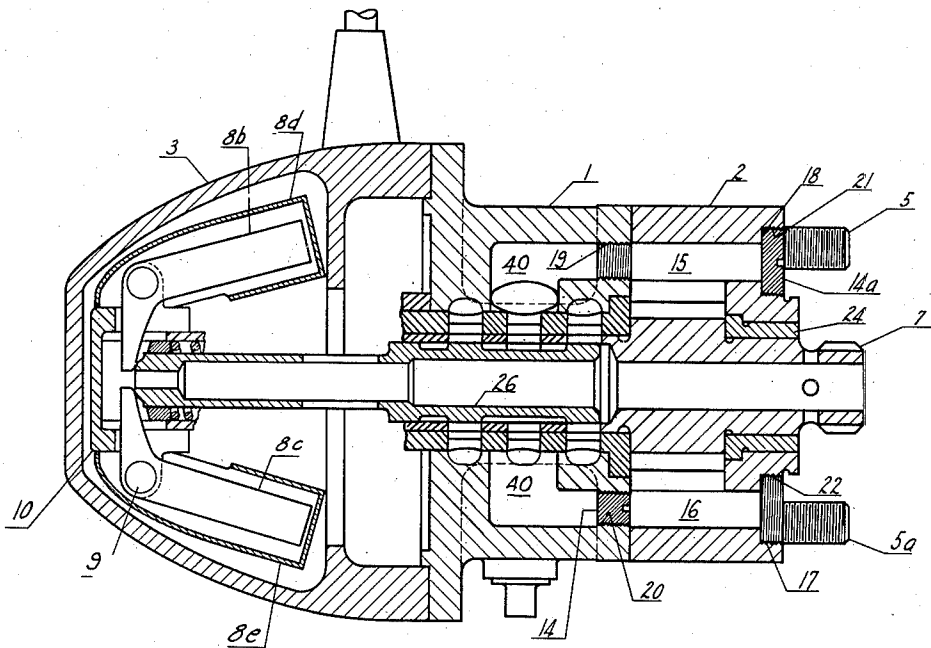


Fig. 6

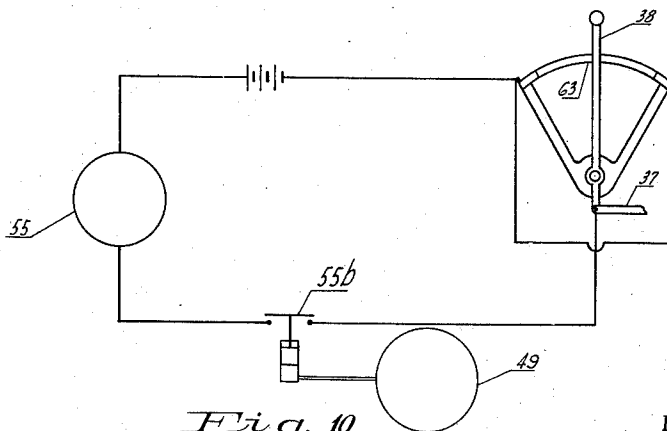


Fig. 10

BY

INVENTOR.

Walter S. Hoover
William B. Jaspert
Attorney.

Nov. 28, 1944.

W. S. HOOVER

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4 Sheets-Sheet 4

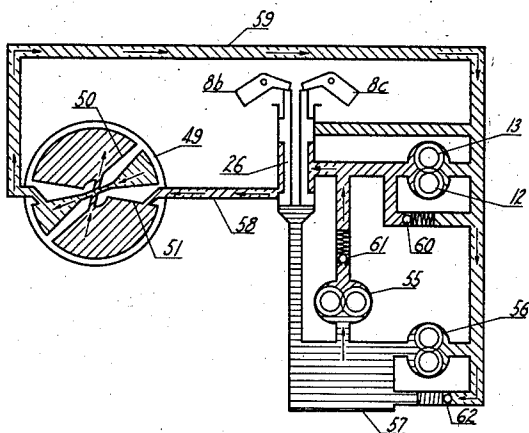


Fig. 8

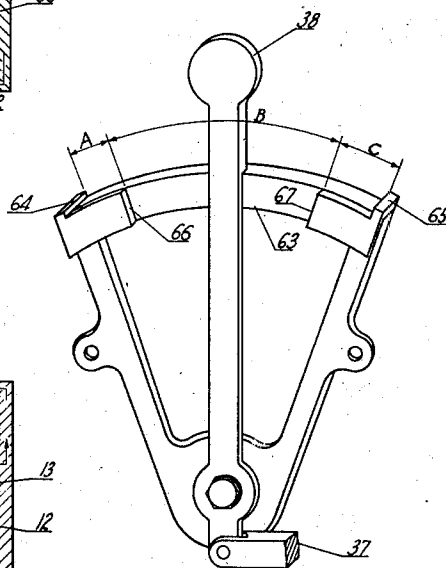


Fig. 7

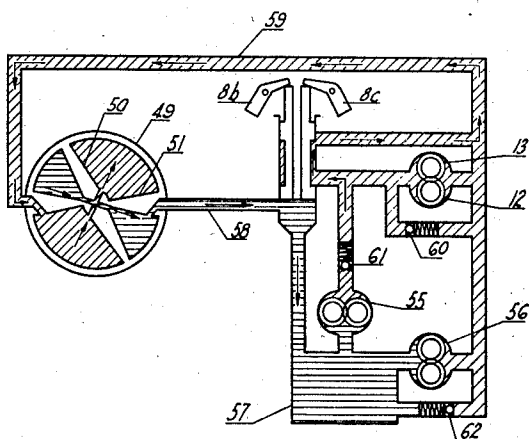


Fig. 9

INVENTOR.

Walter S. Hoover

William B. Jaspert
Attorney.

BY

UNITED STATES PATENT OFFICE

2,363,670

VARIABLE PITCH CONSTANT SPEED
PROPELLER ASSEMBLY

Walter S. Hoover, Montreal, Quebec, Canada

Application August 22, 1940, Serial No. 353,605

5 Claims. (Cl. 170-163)

This invention relates to new and useful improvements in hydraulic governors for automatically controlling constant speed propeller units, and it is among the objects thereof to provide a governor unit of compact durable design and construction, which is operative for feathering and unfeathering or completely reversing propeller blades in a simple and reliable manner.

The invention will become more apparent from a description of the accompanying drawings constituting a part hereof in which like reference characters designate like parts and in which:

Fig. 1 is a cross-sectional view taken longitudinally of a governor unit embodying the principles of this invention;

Fig. 2 a top plan view thereof;

Fig. 3 a rear elevational view thereof;

Figs. 4 and 5 are horizontal sections of a portion of the governor end cap illustrating parts of the manual valve control;

Fig. 6 is a cross-section of the pump housing with interchangeable plugs for changing the direction of the fluid flow;

Fig. 7 is a front elevation of the governor control lever;

Fig. 8 is a diagrammatic view illustrating the routing of hydraulic fluid through the governor for the feathering position of the propeller blades;

Fig. 9 is a similar view illustrating the application of the control fluid for the unfeathering of the propeller blades; and

Fig. 10 is a diagrammatic view illustrating an automatic cut-out for the blade-setting actuating fluid.

The structure will first be described with reference to Figs. 1 to 6 inclusive of the drawings. The numeral 1 designates the governor valve housing, 2 the pump housing and 3 the valve control housing or cap. The valve and pump housings 1 and 2 are forged aluminum alloy pieces accurately machined and drilled with sealed surfaces 4 that are lapped together. The base or pump housing 2 is provided with studs 5 and 5a that fit the standard engine governor pads. The numeral 6 designates the main governor shaft which is of hollow construction and has a splined end 7 that interacts with the spline in the engine shaft. The shaft 6 drives the governor fly-weights 8b and 8c; the fly-weights are pivoted at 9 to a hub cap 10 that is secured to the shaft 6 by a pin 11. As shown in Fig. 6, special fly-weight shields 8d and 8e attached to hub cap 10 to be rotatable therewith, may

be provided for fly-weights 8b and 8c to eliminate interference if the end chamber is filled with oil. The governor shaft 6 is provided with gear teeth 12 that mesh with the teeth of gear wheel 13, which constitute a gear pump to which the fluid is routed.

As shown in Fig. 6, the pump housing is provided with fluid flow passages 15 and 16 having counterbores 17 and 18, respectively, which passages are threaded at 19 and 20 to receive the small plug 14 and threaded at 21 and 22 to receive the large plug 14a.

The small plug 14 is shown in the small threaded opening 20 and the large plug 14a in the large threaded opening 21, Fig. 6. Opening 22 connects to the source of fluid which may be the engine lubricating oil or a separate sump tank. For one direction of rotation of the spline shaft 7 the fluid is pumped through threaded opening 22 and delivered under pressure through opening 19 to the governor valve chamber 40. If the engine shaft that connects with the spline shaft 7 of the pump rotates in the opposite direction, plug 14 is removed from passage 20 and placed in threaded opening 19, and plug 14a is removed and placed in threaded opening 22. Opening 21 is then connected to the fluid source and the fluid is pumped to the governor valve chamber by the gears 12 and 13.

The driving gear 12 is provided with end bearings 23 and 24, and the driven gear 13 with a center bearing 25, Fig. 1. This bearing arrangement produces minimum drag and makes for long life and maintenance of desirable oil pressures.

A main governor control sleeve valve 26 is mounted for axial movement in the governor shaft 6. The valve 26 is attached by a pin 27 to a spring block 28 and is engaged by the arms 28a of the governor fly-weights. The contracting faces 28b of the valve sleeve 26 and governor arms 28a are of involute curve shape to maintain positive contact and to eliminate wear. Valve 26 is a pressure balanced valve actuated in response to movement of the governor fly-weights 8b and 8c, against the compression of a speeder spring 29, which normally biases valve 26 to the position shown in Fig. 1. The speeder spring 29 is pre-loaded by a sleeve 30 that carries a pin 31 passing through clearance slots 32 of the valve sleeve which is in engagement with a spring block 33. Sleeve 30 is actuated by a cylindrical gear rack 30b having gear teeth 34 actuated by gear wheel 35 to increase or decrease the speeder spring load to select and

automatically maintain the desired R. P. M. The gear 35 is actuated by the pulley 36, Fig. 5, or by linkage 37, Fig. 4, that connects to the control lever 38, Fig. 7 which will be hereinafter described in detail.

The flow of the actuating fluid is from the gear pump 12 and 13 through passage 40 to the port 41 or by-pass 42, the latter passage being controlled by by-pass valve 43 that is biased by coil spring 44, which is adjustable by the screw plug 45 to predetermine the fluid pressure delivered by the gear pump which may be 300 pounds per square inch and which is maintained constant by the relief valve 43. The relief valve adjustment may be locked as shown.

For the purpose of locating the speeder spring control shaft 35a the governor cap 3 can be set in any one of four positions by removing screws 46 and turning it through an angle of 90, 180 or 270 degrees, and then replacing the screws 46. The adjustment of the governor cap is made after the pump housing 2 is mounted on the standard engine governor pad. If after mounting the control shaft 35a is not in a position for connecting the control actuator, the head is simply rotated to bring the shaft in desired position and then fastened by the bolts 46. Valve 26, when displaced, routes the fluid from the pump passage 40 to the passages 47 or 48, depending upon the direction of movement of valve 26 as controlled by the governor fly-weights 8b and 8c, passages 47 and 48 leading to the propeller pitch actuator shown in Figs. 7 and 8, which consists of a rotor having movable and stationary abutments 50 and 51, respectively, and which will be hereinafter described. The hollow shaft 6 is the return passage of the fluid which enters the interior of the shaft through openings 47a from port 47b.

The governor cap chamber is provided with a vent 52 leading to the atmosphere and the back of by-pass valve 43 is relieved by passage 53 leading to the chamber 30a. Passage 42 is provided with a segmental slot 42a to maintain communication with the fluid sump passage of the fluid supply tank or motor, as the case may be.

For the purpose of illustrating the preloading of the speeder spring 29, Fig. 1, it is shown in both the compressed and extended positions, with the pin 31 broken at the center.

With reference to Figs. 8 and 9 of the drawings, the governor booster pump gears 12 and 13 are diagrammatically illustrated. Figs. 8 and 9 also show an auxiliary electric motor driven pump 55 and an engine pump 56. The electrically driven pump is mounted on the governor unit by removing the gland 55a, Fig. 2, and screwing the pump gland in the opening. One pump may supply high pressure fluid to a plurality of governor units. The numeral 57 in Figs. 8 and 9 designates an oil tank, and the governor valve 26 and the valve fly-weights 8b and 8c are also diagrammatically illustrated. The fluid connections between the hydraulic actuator 49, which effects adjustment of the pitch setting of the propeller blades and the governor valve, are designated by the numeral 58; the return flow passage by the numeral 59. The numerals 60, 61 and 62 designate relief valves that determine the fluid pressure developed by the governor booster pump 12, 13, the auxiliary electric motor driven pump 55 and the engine pump 56, respectively.

The application and flow of fluid is indicated by arrows in Figs. 8 and 9, and the control thereof

is effected through lever 38 mounted on the segment bracket 63, having end stops 64 and 65, with intermediate stop positions 66 and 67, Fig. 7. The control range, as effected by movement of lever 38, is designated by sections A, B and C between the arrows, the range B being the normal control range for constant speed, range A the feathering control range, and range C the reverse and unfeathering range.

The application of the fluid, as shown through the governor control valve 26, Fig. 8, is in range A, with lever 38 moving between positions 64 and 66. In this position of the lever, speeder spring 29 forces valve 26 to its full port open position and the fluid, as shown by arrows, is delivered by the auxiliary pump 55, through the ported passages of valve 26, to passage 58 leading to the hydraulic actuator which is subjected to angular displacement to effect full feathering adjustment of the blade. Fig. 9 diagrammatically illustrates the flow of fluid for unfeathering the propeller blades by movement of lever 38 in range C against stop 65 to raise the valve, and, as shown by arrows, the application of the fluid is from the auxiliary pump 55 in the reverse direction, with return flow to the oil tank 57.

Automatic control by the governor is effected by the governor fly-weights which move in response to variations in the engine speed to adjust the valve setting, which causes a change in the pitch setting of the blades to compensate for the difference in speed, thereby retaining a constant speed of the propellers under all load conditions. When the R. P. M. decreases, the fly-weights contract, which causes spring 29 to move the valve in the opposite direction, to decrease the pitch setting. When the propeller is rotating at normal speed the governor valve 26 is in the position shown in Fig. 1 and the fluid flow in passage 40 is blocked in the valve as both the flow passages 47 and 48 are closed. Consequently, in this position of the governor valve, the pressure building up in the passage 40 will cause the relief valve 43 to open and the oil from the booster pump is by-passed to the passage 42. When either increasing or decreasing pitch, the relief valve is closed and the oil is conducted through channels 58 or 59, to the torque unit 49, Figs. 8 and 9.

The above description of operation is made with reference to a double acting oil system, but the governor unit herein described is adapted to a single acting oil gland by merely plugging one of the outlets 58 or 59. The spring loading is effective to keep the engine constantly on the selected speed within one revolution per minute.

To obtain rapid feathering, the auxiliary electric motor driven pump 55, Figs. 8 and 9, is energized. Oil from this pump is routed by manual operation of the governor valve through lever 38 into the same increasing and decreasing pitch channels 58 and 59 employed in normal constant speed operation. All the routing of the oil from auxiliary pump 55 is accomplished in the governor to which it is attached, no special valves being required between the governor and the propeller unit.

To feather the blades, the governor control lever 38 is moved to the extreme increased angle position, which is in the range A of the segment, Fig. 7. This starts the feathering operation, which automatically stops when the blades reach their feathered position. For unfeathering, the

governor control lever is moved to its opposite extremity of travel in control range C until the engine starts. The lever is then placed to give the desired R. P. M. in normal control range B and the governor resumes its normal function.

The motor of the auxiliary pump 55 is electrically connected to be energized by governor control lever 38 when it is moved to its extreme increased pitch position against stop 64, as shown in Fig. 10, and this movement simultaneously positions the governor valve, as shown in Fig. 8, to route the fluid to the torque motor 49 through passage 59, as shown by arrows. When the governor control lever strikes the feathering stop 64, the pump motor 55 is energized and auxiliary oil pressure shoots suddenly upward and a small oil pressure switch 55b, shown in Fig. 10 as connected to the torque unit 49 breaks the pump motor circuit, automatically stopping the operation.

Thus the propeller requires a minimum of attention from the pilot during the period of emergency. From the diagram it will be noted that if the blades need to be feathered while the engine is still running, the capacity of the governor pump 12, 13, is also available, thus making it possible to feather extremely fast in acute emergencies.

Movement of the governor control lever 38 in the opposite extreme travel against stops 65 again starts the auxiliary pump 55 and positively positions the governor distributor valve 26, as shown in the unfeathering diagram, Fig. 9. Oil flows from pump 55 to valve 26, as shown by the arrows, and thence to the torque motor 49. The oil from the pump 55 backs up against the engine lubrication system, thereby attaining sufficient pressure to unfeather the blades. It also lubricates the engine bearing surfaces if the engine has been stationary and drained free of oil. This makes it easier for the propeller to windmill, and reduces the possibility of the bearings running dry while the propeller is cranking the engine. As soon as the engine starts, the governor control lever is moved to the position giving the desired R. P. M. range B, thus opening the auxiliary oil pump switch and allowing the governor to resume normal operation.

It will be noted that the pilot has only one simple control, namely, the lever 38, to operate the complete propeller system through the full range of adjustments. This simplifies the pilot's job and reduces the wiring, piping, switch, and control equipment in the cock pit.

It is evident from the foregoing description of the invention that the governor valve and auxiliary controls disclosed therein provide for complete automatic control for maintaining a constant desired R. P. M. of the propeller motors; a manual control for setting the pitch of the propeller blades to their extreme angular position or full feathering position; an auxiliary full volume high pressure fluid with manual control for rapid feathering in case of an emergency, with automatic restoration of the governor control for constant speed operation; and manually controlled auxiliary means for pitch setting to crank the motors when stopped in flight with automatic restoration to normal governor control for constant speed setting.

I do not claim manual operation of a governor control valve as novel per se because it was originally described by me in my Patent No. 1,972,486.

Although one embodiment of the invention has

been herein illustrated and described, it will be evident to those skilled in the art that various modifications may be made in the details of construction without departing from the principles herein set forth.

I claim:

1. In an hydraulically operated variable pitch propeller control mechanism, comprising a valve housing, a pump housing and governor fly-weight housing assembled as a unit, a main hollow drive shaft extending through said unit having connection with the propeller engine, a fluid pump driven by said shaft embodying means for limiting the pressure of the fluid delivered by said pump and governor fly-weights driven by said shaft, a fluid control valve disposed within said drive shaft, speed responsive mechanism operative by said fly-weights for subjecting said valve to axial movement, a speeder spring for pre-loading said speed responsive mechanism, a plurality of fluid flow passages to said pump and from said pump to said valve passages for routing fluid as directed by said valve to the propeller pitch setting mechanism and for recirculating the fluid in one position of said valve, and an independent source of pressure fluid connected to said valve having a motor driven pump, and manual means for setting the speeder spring to obtain a desired propeller blade pitch setting, said means being operative only in its extreme control range to energize said last-named pump-motor.

2. In an hydraulically operated variable pitch propeller mechanism, a fluid pressure responsive means for setting the pitch of the propeller blades, a source of limited pressure fluid for said pitch setting means, a control valve for routing said fluid of limited pressure to and from said pitch setting means, governor actuated means controlling said valve in response to the propeller speed, manually actuated auxiliary controls for said governor mechanism, a source of high pressure fluid for said pitch setting means, means energized by said auxiliary controls only at their extreme control range for delivering high pressure fluid to said propeller mechanism, and means responsive to the pressure of the fluid delivered to the propeller actuating means for disconnecting said high pressure fluid delivering means.

3. In a controllable pitch propeller, a hub structure, propeller blades movably mounted therein, a fluid actuator connected to said blades for their pitch adjusting movements, fluid pressure means for said actuator, governor valve means controlling the application of said fluid pressure for adjusting the pitch setting of the blades in response to variations in the engine speeds, a second source of fluid pressure for said blade actuator of sufficient pressure in excess of the pressure of said first-named fluid pressure means to adjust the blades to full angular position, and manual control means for said governor valve including means operable only at the extreme control range for rendering the second source of fluid pressure operative.

4. In a constant speed propeller mechanism, a hydraulic actuator for adjusting the pitch setting of the propeller blades, a source of pressure fluid, embodying means for limiting the pressure of said fluid, a governor control valve directing the pressure fluid to said actuator, a motor driven pump connected to the governor valve for application of high pressure fluid to the actuator and a manually operable control for regulating the governor valve independently of the propeller speed, said control being operable in only the

extreme control range of its valve adjusting movements for energizing the fluid pump motor.

5. In a controllable pitch propeller, a hub structure, propeller blades movably mounted therein, a fluid actuator connected to said blades for their pitch adjusting movements, fluid pressure means for said actuator embodying pressure responsive means for limiting the pressure of the actuating fluid, governor valve means controlling the application of said fluid pressure for adjusting the pitch setting of the blades in response to vari-

ations in the engine speeds, a second source of fluid pressure for said blade actuator of sufficient pressure in excess of the pressure of said first-named fluid pressure means to adjust the blades to full angular position, and manual control means for said governor valve including means operable only at the extreme control range for rendering the second source of fluid pressure operative.

WALTER S. HOOVER.