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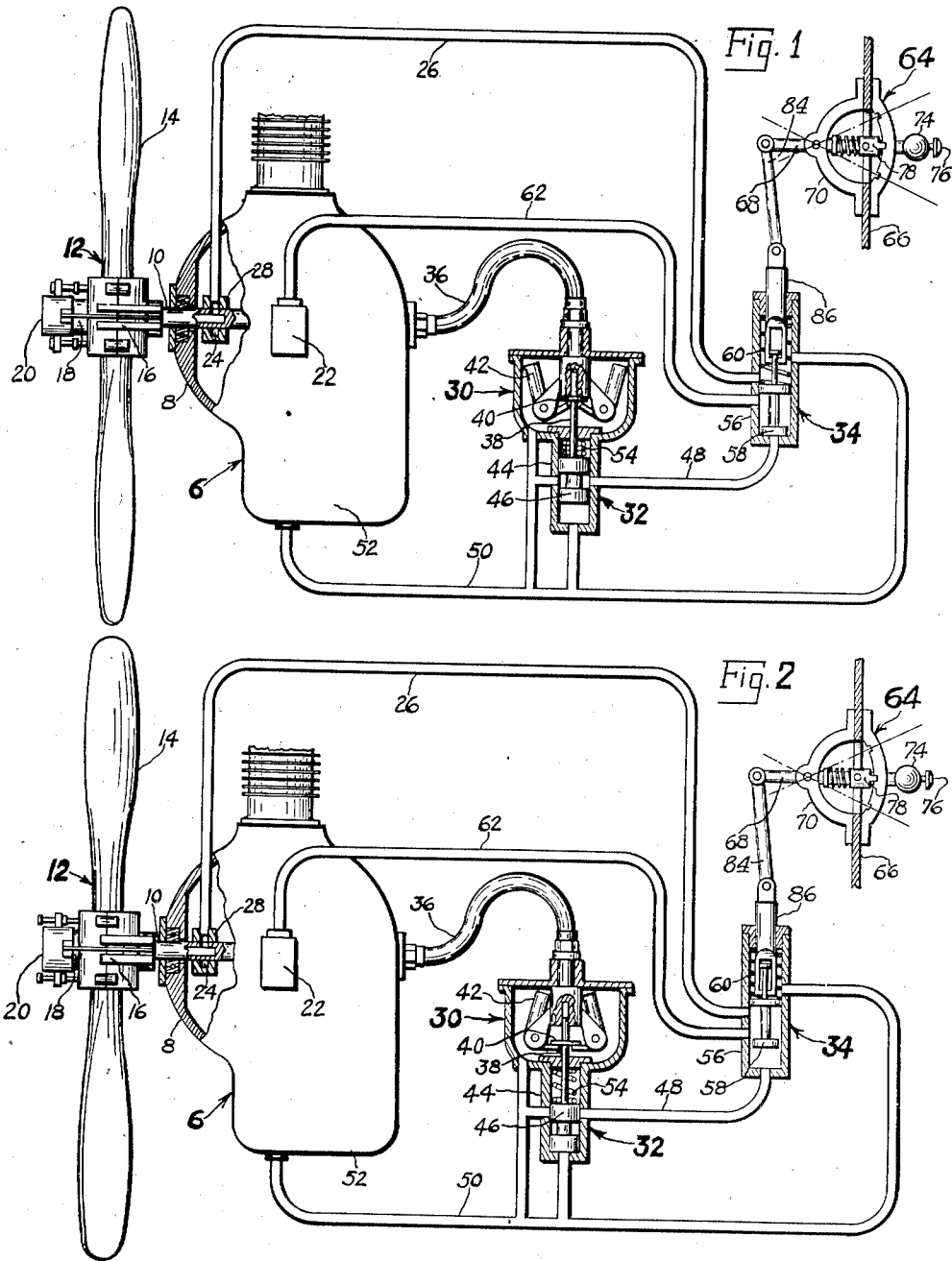
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CONTROL MEANS FOR CONTROLLABLE PROPELLERS

Filed June 8, 1935

2 Sheets-Sheet 1



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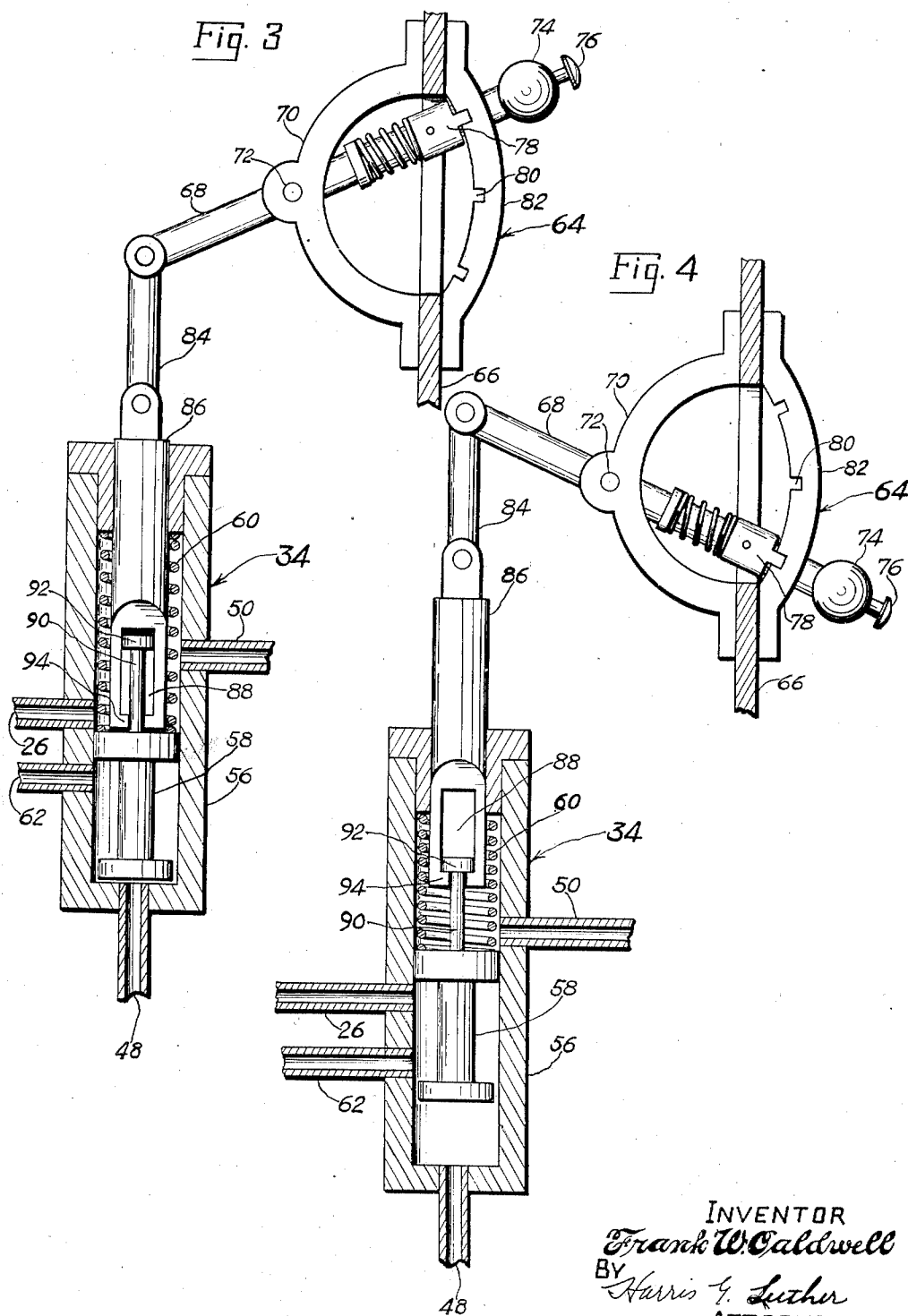
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CONTROL MEANS FOR CONTROLLABLE PROPELLERS

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9 Claims. (Cl. 170—163)

This invention relates to improvements in control means for controllable propellers and has for an object the provision in combination with an automatic control means for a controllable propeller for airplanes, of manual means for adjusting the propeller while it is under the control of the automatic means.

Other objects and advantages will appear as the description proceeds.

In the accompanying drawings in which like reference numerals are used to indicate similar parts throughout, I have illustrated a suitable embodiment of what is now considered the preferred form of the invention. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting the invention, the scope of which is to be measured entirely by the scope of the appended claims.

In the drawings, Fig. 1 is a schematic view of my improved control mechanism in one operative position, certain portions being shown in section to better illustrate the construction thereof. Fig. 2 is a schematic view similar to Fig. 1 showing my improved control mechanism in a different operative position. Fig. 3 is an elevational view of the manually operable portion of my improved control mechanism in one operative position, and Fig. 4 is an elevational view similar to Fig. 3 showing the manually operable portion of my improved control mechanism in a different operative position.

Referring to the drawings in detail, the numeral 6 generally indicates a prime mover of suitable construction such as a radial internal combustion engine of the type commonly used for the propulsion of aircraft. This prime mover, or engine, has a crankcase 8, from which projects a rotatable power shaft 10, the projecting end of which is drivingly connected to a propeller generally indicated at 12.

The propeller 12 is of the controllable type, the blades as indicated at 14 being rotatable about their longitudinal axes to change the blade angle or the angle of attack of the blade upon the air through which the blade moves. The controlling means comprises a centrifugal member as indicated at 16 secured to each blade adjacent to the root or hub portion thereof and acting to increase the blade angle when the propeller is rotating, and a hydraulic means opposed to the centrifugal means and including a piston 18 and a cylinder 20 suitably connected to the propeller blades 14 in such a manner that when a fluid, such as oil, under pressure is admitted to the space between the piston 18 and the cylinder 20,

the consequent movement of the cylinder will rotate the propeller blades 14 against the action of the centrifugal means 16 in a direction to decrease the blade angle of the propeller.

The fluid under pressure may be obtained from any suitable pressure source, such as the oil pump 22 of the engine 6, and is preferably led into the space between the piston 18 and the cylinder 20 by means of a bore 24 in the power shaft 10 connected to an oil pressure line 26 by means of a suitable oil collector ring 28.

In order to automatically regulate the blade angle of the propeller to maintain a constant rotational speed and consequently a constant operating speed in the engine 6, I have interposed between the pump 22 and the propeller pressure line 26, a suitable control mechanism including a governor generally indicated at 30, a pilot valve generally indicated at 32, and a servo valve generally indicated at 34.

The governor is driven from the engine by a suitable driving connection 36 operatively connected to one of the rotating parts of the engine. Obviously, the governor may be driven at engine speed or at some fraction or multiple thereof, depending upon the rotating member to which the driving connection 36 is attached. The governor illustrated is of the flyball type and is operatively connected to the pilot valve 32 by means of a valve stem 38 and thrust plate 40 so that radial movement of the flyballs 42 caused by centrifugal force acting upon the flyballs will impart axial movement to the valve stem 38. The pilot valve 32 has a cylinder 44 within which is a reciprocating double piston 46 operatively connected to the valve stem 38 to move therewith under the control of the flyballs 42. The pilot valve 32 is connected at one side thereof to one side of the servo valve 34 by means of a suitable fluid conduit 48, and at the opposite side is connected by means of a suitable conduit 50 with the oil sump 52 of the engine 6, so that in the operative position of the parts illustrated in Fig. 1, the pilot valve will connect one side of the servo valve with the engine oil sump and thus provide a drain for relieving pressure in the side of the servo valve to which the pilot valve is connected. The space between the opposite ends of the piston 46 and the corresponding ends of the cylinder 44 may also be connected with the drain line 50 in order to provide for free movement of the piston in the cylinder. Preferably the pilot valve is biased in one direction by means of a coiled compression spring 54 interposed between one end of the piston 46 and the adjacent end of

the cylinder 44, the force of this spring being opposed to the centrifugal action of the flyballs 42 and tending to move the piston 46 against the action of the governor.

5 The servo valve 34 has a cylinder 56 within which is a reciprocal double piston 58, urged in one direction within the cylinder by means of a coiled compression spring 60 interposed between one end of the piston and the adjacent end of the cylinder. One side of the cylinder 56 is 10 connected to the oil sump 52 by means of the drain line 50, and the opposite side thereof is connected to the oil pump 22 by means of an oil pressure line 62, and to the hydraulic propeller control mechanism by means of the propeller line 26, the lines 50, 62, and 26 being connected to the cylinder 56 by suitable ports so arranged that when the piston 58 is in one operative position as illustrated in Fig. 1, it will connect the propeller line 26 with the drain 50, and 20 when it is in its other operating position, as illustrated in Fig. 2, it will connect the propeller line 26 with the oil pressure line 62.

The operation of the mechanism so far described is as follows:

If the engine 6 is operating at a speed above that of the predetermined speed for which the control mechanism is set, the flyballs 42 of the governor 30 will move outwardly and move the valve stem 38 in a direction to move the piston 46 against the force of the spring 54 to the position illustrated in Fig. 1, thus connecting the space between the piston 58 of the servo valve 34 opposite the spring 60, and the adjacent end of the cylinder 56 of the servo valve with the drain 35 line 50. When the pressure in the space between the piston 58 and cylinder 56 of the servo valve is thus relieved, the spring 60 forces the piston 58 to the operative position illustrated in Fig. 1 in which position the propeller line 26 is connected with the drain line 50 allowing oil to flow from the hydraulic propeller control mechanism to the engine oil sump 52. When the pressure in the hydraulic propeller control mechanism is 45 relieved, the centrifugal members 16 will act to increase the blade angle of the propeller and thus place an additional load upon the engine 6, reducing its speed to the speed for which the control mechanism is adjusted.

If, on the other hand, the engine speed is below the predetermined speed for which the control mechanism is adjusted, the spring 54 in the pilot valve 32 will force the piston 46 to the operative position illustrated in Fig. 2 and move the flyballs 42 inwardly against the action of centrifugal force. When the double piston 46 is in the operative position illustrated in Fig. 2, one end thereof is interposed between the ports connecting the drain line 50 and the pilot valve conduit 60 48, and thus prevents fluid from draining from the space between the end of the piston 58 opposite the spring 60 and the adjacent end of the cylinder 56. As the line 62 connecting the oil pump 22 with the servo valve 34 is always open, the closing of this drain will cause pressure to 65 build up under the piston 58 by reason of the pressure fluid leaking past the small end of the piston 58, and this pressure will move the piston against the force of the spring 60 to the operative position illustrated in Fig. 2, in which position the pressure line 62 is hydraulically connected with the propeller line 26, thus permitting fluid under pressure to flow to the hydraulic propeller adjusting mechanism. As the pressure 70 builds up in the propeller adjusting mechanism,

this mechanism operates to decrease the blade angle of the propeller, thereby relieving the engine of a portion of its load and permitting the engine to speed up to the predetermined speed for which the control mechanism is set. Thus 5 it will be seen that the improved automatic control mechanism normally maintains the engine and propeller at a constant operating speed.

There are certain times when it is desired to obtain additional power from the engine, as during the take-off and climb of the airplane, which 10 additional power may be obtained by maintaining the propeller at a low blade angle and permitting the engine to temporarily speed up or over-rev. There are likewise times, as during a 15 dive, when it is desirable to maintain the propeller at the highest available pitch angle in order to prevent undue speeding up of the propeller and engine. It is, therefore, one of the objects of this invention to provide a manual 20 control means for taking the control of the controllable propeller away from the automatic means and maintain the propeller in either its high pitch or low pitch condition according to the will of the operator of the airplane. 25

The manual control mechanism generally indicated at 64 is suitably mounted upon the instrument board 66 or some other convenient part of the airplane. In what is now considered the preferred form of the device, the manual control 30 comprises, a hand lever 68, pivotally connected to a bracket 70 by means of a suitable pivotal connection 72, the hand lever preferably extending beyond the pivotal connection upon opposite sides thereof. One end of the hand lever 68 extends into the cockpit or operating compartment of the airplane to within convenient reach of the operator and is there provided with a hand knob 74 and a lock release 76 operatively connected to a spring-pressed detent 78 which engages in any 40 one of three notches as indicated at 80 provided in a guide bar 82 secured to the instrument board 66 on the opposite side thereof from the bracket 70. There are three notches 30, of which the middle one positions the manual control in its 45 neutral position so that it does not affect the operation of the automatic control; the notches on the opposite sides of the middle notch position the manual control in one or the other of two operative positions to maintain the propeller in either its high pitch or its low pitch 50 condition. The lever 68 may be positioned in any one of its three positions by pressing the lock release 76 to remove the detent from the notch in which it is then engaged, moving the lever to its desired position and releasing the lock release to allow the detent to engage in the notch at the desired operating position of the manual control. The neutral position of the manual control is clearly illustrated in Figs. 1 and 2. The 60 position for maintaining the propeller in its high pitch condition is illustrated in Fig. 3, and the position for maintaining the propeller in its low pitch condition is illustrated in Fig. 4. The lever 68, at the end opposite the hand knob 74, is connected by means of a pivoted link 84 with a 65 plunger 86 fitted into one end of the cylinder 56 of the servo valve 34. At its inner end the plunger 86 projects within the spring 60 and is provided with an internal bore 88 into which projects a stem 90 secured to that end of the piston 58 which contacts the spring 60. The plunger included end of the stem 90 is provided with an enlargement or stop 92 which engages with a stop engaging arrangement such as the inwardly extending pro- 75

jections 94 provided on the plunger 86 at the outer end of the bore 88. The connection between the plunger 86 and the stem 90 is a lost motion connection, the relative motion between the two parts being such that when the manual control mechanism is in its neutral position as illustrated in Figs. 1 and 2, the piston 58 may move back and forth in the cylinder 56 from one to the other of its two operative positions without restraint by the manual control. However, when the manual control is in the operative position illustrated in Fig. 4, the detents 94 will engage the stop 92 and maintain the piston 58 in the operative position illustrated in Fig. 2, thereby continuously connecting the hydraulic propeller control mechanism with the oil pressure line to maintain the propeller in its low pitch condition. When the manual control is in the operative position as illustrated in Fig. 3, the end of the bore 88 engages the stop 92 and maintains the piston 58 in the operative position illustrated in Fig. 1, thus continuously connecting the propeller line 26 with the drain 50 to maintain the propeller in its high pitch condition.

From the above description it will be observed that I have provided in combination with an automatic control for an adjustable propeller, a manual control for overriding the automatic control and maintaining the adjustable propeller in the condition desired by the operator of the vehicle to which the propeller is attached.

While I have illustrated and described a specific mechanical embodiment of the idea of my invention, it will be understood that the invention is not limited to the mechanical arrangement so illustrated and described, but that such changes in the size, shape, and arrangement of parts may be resorted to as come within the scope of the sub-joined claims.

Having now described my invention so that others skilled in the art may clearly understand the same, what I claim and what I desire to secure by Letters Patent is as follows:

1. In combination with a controllable pitch propeller and means for driving the same, hydraulic means for automatically changing the blade angle of said propeller, valve means for controlling said hydraulic means, a governor actuated pilot valve for adjusting said valve means in response to the speed of said propeller driving means to cause said driving means to drive said propeller at substantially constant speed, and manual means operatively associated with said valve means having three operative positions, one of which is a neutral position for maintaining said hydraulic means under the control of said governor actuated pilot valve, the other two of which are control positions for rendering said governor actuated pilot valve ineffective and controlling said valve means to maintain the propeller in a condition of positive high or low blade angle independently of the action of said governor.

2. In combination with a controllable pitch propeller and means for driving the same, hydraulic means for automatically changing the blade angle of said propeller, governor means responsive to the speed of said propeller driving means, a valve actuated by said governor, a second valve normally operated by said governor actuated valve to control said hydraulic means to cause said driving means to drive said propeller at substantially constant speed, and manual means for controlling said second valve independently of said governor to adjust said propeller

comprising, a pivotally mounted hand lever, a lost motion connection between one end of said hand lever and said valve, and means for releasably retaining said manual means in any one of a plurality of operative positions.

3. In combination with a controllable pitch propeller and means for driving the same, hydraulic means for automatically changing the blade angle of said propeller, a governor and means actuated by said governor for controlling said hydraulic means in response to the speed of said propeller driving means to cause said driving means to drive said propeller at substantially constant speed, and manual means for controlling said hydraulic means independently of the action of said governor, a lost motion connection between said manual means and said governor actuated means, and means for releasably locking said manual means in any one of a plurality of operative positions comprising, a detent on said manual means, and a guide bar for said manual means having notches for receiving said detent.

4. In combination with a controllable pitch propeller and means for driving the same, hydraulic means for automatically changing the blade angle of said propeller, a conduit for supplying fluid under pressure to said hydraulic means and releasing said fluid therefrom, a servo valve in said conduit, a pilot valve hydraulically connected with said servo valve for actuating the same, a governor for controlling said pilot valve in response to the speed of said propeller driving means, and manual means for actuating said servo valve independently of the effect of said pilot valve thereon.

5. In combination with a controllable pitch propeller having a range of pitch adjustment between fixed limit stops, hydraulic means for changing the pitch of said propeller, speed responsive means, valve means actuated by said speed responsive means for normally controlling said hydraulic means, a yieldable connection between said speed responsive means and said valve means, manually actuatable means controlling said valve means, and a lost motion connection between said manual means and said valve means whereby said manual means may be operated to selectively maintain said propeller in an extreme pitch condition against either of said fixed limit stops independently of the action of said speed responsive means.

6. In combination with a controllable pitch propeller having a range of pitch adjustment between fixed limit stops, hydraulic means for changing the pitch of said propeller, speed responsive means, valve means actuated by said speed responsive means for normally controlling said hydraulic means, a hydraulic connection between said speed responsive means and said valve means, manually actuatable means for controlling said valve means independently of said speed responsive means, and a lost motion connection between said manually actuatable means and said valve means effective only in its extreme positions to maintain said propeller in an extreme pitch condition against either of said fixed limit stops upon selective movement of said manually actuatable means.

7. In combination with a controllable pitch propeller having a range of pitch adjustment between fixed limit stops, hydraulic means for changing the pitch of said propeller, a valve for controlling the operation of said hydraulic means, speed responsive means normally controlling said valve, a yieldable connection between said speed

- responsive means and said valve and manually actuable means having a lost motion connection with said valve for positively moving said valve in either direction when said manual means is selectively moved to either extreme position to maintain said propeller in an extreme pitch condition against either of said fixed limit stops independently of the action of said speed responsive means.
8. In combination with a controllable pitch propeller, hydraulic means for changing the pitch of said propeller, a servo valve for controlling the operation of said hydraulic means, a pilot valve normally controlling said servo valve, speed responsive means for operating said pilot valve, and manually actuable means for operating said servo valve independently of said speed responsive means.

9. In combination with a controllable pitch propeller having a range of pitch adjustment between fixed limit stops, hydraulic means for changing the pitch of said propeller, a valve controlling said hydraulic means, a governor responsive to the speed of the propeller for actuating said valve in one direction, a spring for actuating said valve in opposition to said governor, and manual means operatively connected with said valve having a neutral position in which said valve is under the control of said governor and said spring, said manual means being operable to hold said valve in either limiting position against the action of said governor or said spring to retain said propeller at the corresponding end of said pitch adjustment range.

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DISCLAIMER

2,145,859.—*Frank W. Caldwell*, Hartford, Conn. CONTROL MEANS FOR CONTROLLABLE PROPELLERS. Patent dated February 7, 1939. Disclaimer filed July 13, 1939, by the assignee, *United Aircraft Corporation*; the inventor approving and consenting.

Hereby enters this disclaimer to claim 9 in said specification.
[*Official Gazette August 8, 1939.*]