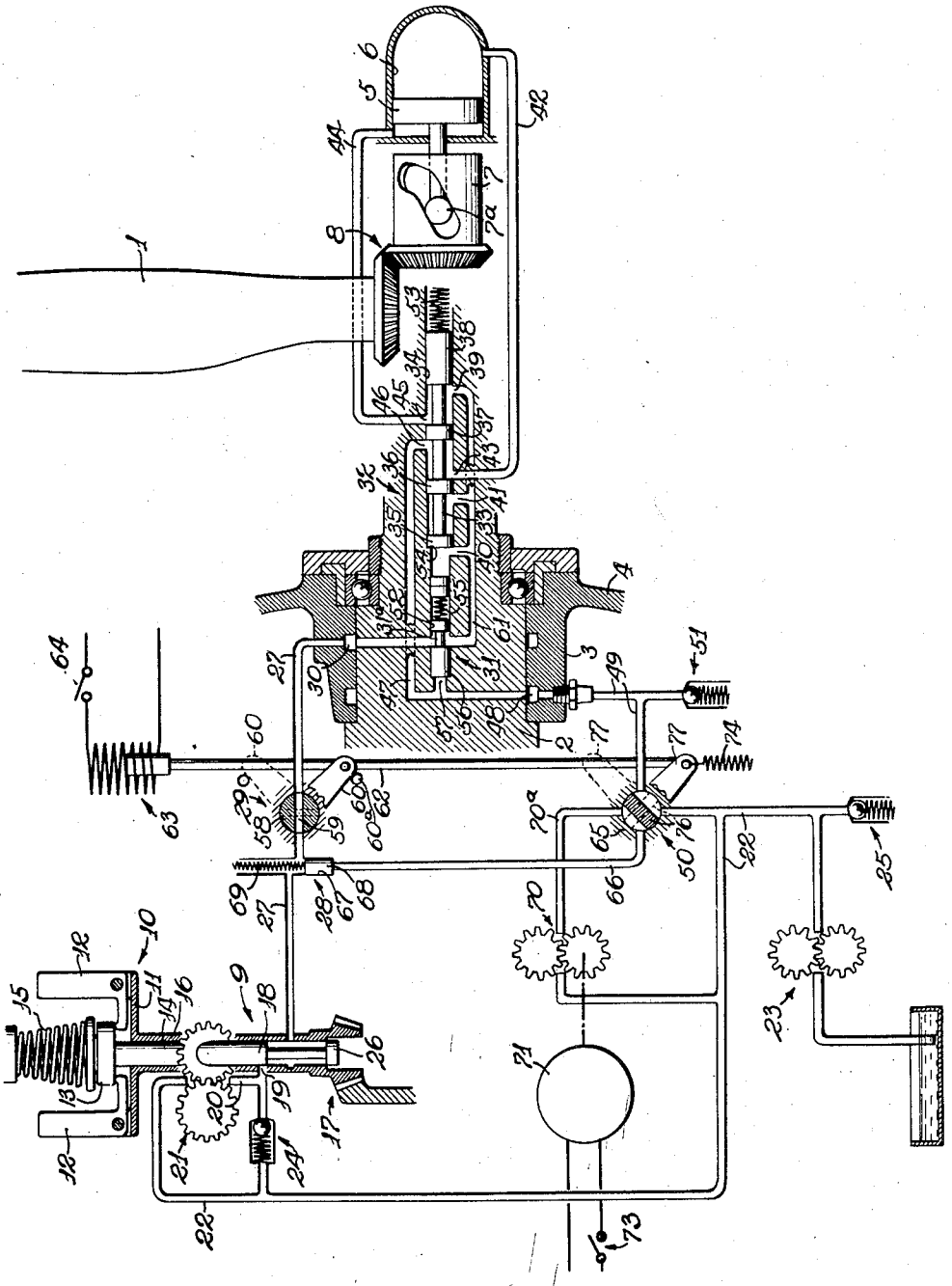
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PITCH CONTROL MECHANISM

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PITCH CONTROL MECHANISM

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This invention relates to mechanisms for controlling the pitch of propellers for aircraft or the like and has more particular reference to mechanisms of the hydraulic type.

The general object is to equip a propeller adjusting mechanism of the above character with selectively operable means by which the propeller blades may be locked positively at some fixed pitch so as to assist in proper setting of the carburetor mixture of the engine by which the propeller is driven.

Another object is to provide such a blade lock in which the pitch adjusting servo is utilized to apply the locking force.

A further object is to provide an hydraulic blade lock which is not affected by leakage of pressure fluid at the rings through which the fluid is transferred from the stationary to the rotating parts.

Still another object is to adapt the blade locking mechanism for control from a remote point.

It is another object to utilize the auxiliary feathering pump as a source of locking pressure.

The invention also resides in the novel arrangement of valves by which the locking action is effected.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawing which is a schematic view and circuit diagram of an hydraulic pitch control mechanism involving the novel features of the present invention.

The invention is susceptible of various modifications and alternative constructions and of use with various kinds of blade adjusters, and I have shown in the drawing and will herein describe in detail a preferred embodiment of the invention applied to a common type hydraulic adjusting mechanism. It is to be understood, however, that I do not intend to limit the invention by such disclosure but aim to cover all modifications and alternative constructions and uses falling within the spirit and scope of the invention as expressed in the appended claims.

The pitch adjusting mechanism in which the invention is incorporated is a so-called "hydromatic" system adapted to adjust the pitch of the blades 1 of an airplane propeller to maintain a constant speed of the engine by which the propeller is driven. The blades are mounted on the end of the engine crankshaft 2 which projects forwardly through a hub 3 at the front of the engine frame 4. The blade pitch is changed by an hydraulic actuator or servo rotatable with the

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propeller and comprising a double acting piston 5 reciprocable in a cylinder 6 to actuate rollers 7a that operate on a cylindrical cam 7 to turn the propeller blades through bevel gears 8. The blades tend to turn toward low pitch under their centrifugal twisting moment, and turning toward high pitch is controlled by forcing oil under pressure into the rod end of the cylinder 6.

In order to adjust the blade angle as required for the maintenance of a constant engine speed, the flow of oil is metered by a valve 9 actuated in response to engine speed changes detected by a centrifugal governor 10. As shown, the governor includes a rotary head 11 pivotally supporting flyballs 12 having arms bearing upwardly against the head 13 of a valve rod 14 which is urged downwardly by an adjustable speeder spring 15. The ball head 11 is on the upper end of a sleeve 16 journaled in the governor casing and driven from its lower end through a gear connection 17 with the engine crankshaft 2. The valve rod has a land 18 which cooperates with a port 19 in the sleeve 16, the latter in turn communicating with a conduit 20 constituting the outlet of a booster pump 21. Oil is delivered to the pump from a branch 22 leading from the outlet of a gear pump 23 that supplies oil at low pressure to the engine lubricating system. The pressures developed by the pumps are determined by the setting of by-pass valves 24 and 25.

The lower end of the valve sleeve 16 may be opened and closed according to the position of a land 26 on the lower end of the stem 14. Intermediate the lands 18 and 26, the sleeve is ported and communicates with a conduit 27 which leads through valves 28 and 29 and the usual transfer ring 30 to a valve 31 which forms a part of the present blade lock control and the usual distributor valve 32, both valves being disposed within the engine shaft 2. The distributor valve comprises a plunger 33 slidable in a cylinder 34 and having spaced lands 35, 36, 37 and 38. The cylinder communicates through ports 39, 40 and 41 with a supply conduit 61 leading from the transfer ring 30. A conduit 42 extends from a port 43 to the head end of the cylinder 6 while the rod end of the cylinder communicates through a conduit 44 with a port 45 between the lands 37 and 38. Another port 46 opening between the lands 36 and 37 leads through a conduit 47 to a collector ring 48 which is connected through a conduit 49 and a valve 50 to the supply line of the lubricating pump 23. A pressure relief valve 51 is connected to the line 49 and set to pass oil at a pressure somewhat above that delivered by

the pump 23 and determined by the setting of the valve 25. A spring 53 urges the plunger 33 toward the position shown in which the land 35 abuts against a shoulder 54.

The plunger 31a of the valve 31 is slidable in a cylinder 52 through which the supply conduit 61 extends. A spring 55 strong enough to overcome the normal pressure of the lubricating system urges the plunger to the left as shown, a piston 56 then being disposed in the remote end of the cylinder which communicates through a port 57 with the conduit 47.

The valve 29 has a rotary member 58 through which extends a passage 59 which, when turned to the position shown in dotted outline, interrupts the flow of pressure fluid through the conduit 27 to the distributor valve 32. An arm 60 fast on the valve member is connected to a rod 62 which carries the armature of a solenoid 63 energizable by closure of a switch 64 at a remote point of control. When the solenoid is deenergized, a spring 74 holds the valve 29 in open position as shown and as determined by a stop 60a. The valve is closed as indicated in dotted outline when the solenoid is energized.

At a point disposed opposite the conduit 49, the casing 65 of the valve 50 communicates with a conduit 66 leading to a cylinder 67 in which there is the piston 68 of the valve 28. This is normally urged by a spring 69 to the position shown in which fluid is permitted to flow through the conduit 27. Opposite the conduit 22, the valve casing 65 communicates with a conduit 70a leading to the outlet of a gear pump 70 driven by an electric motor 71 and having its inlet 72 connected to the oil supply line 22. This pump is adapted to provide fluid pressure for feathering the propeller. The circuit for the motor 71 is closed under the control of a switch 73 in the control cabin.

The valve 50 has a member 76 rotatable within the casing 65 and carrying an arm 77 connected to the rod 62 for actuation of the two valves in unison under the control of the solenoid 63. In the normal position shown, the member 76 is positioned to connect the conduits 22 and 49 and also the conduits 66 and 70a. In the other position of the member shown in dotted outline, the conduits 49 and 70a are connected and 66 is connected to the conduit 22.

The circuit arrangement thus far described is that of the so-called "hydromatic" control with the addition of the valves 29, 31 and 50. The parts will be positioned as shown when the engine is operating at the speed corresponding to the setting of governor speeder spring 15. An increase in engine speed raises the pilot valve member 14 admitting oil from the governor pump into the sleeve 16. The oil flows through the cut-off valve 28, the transfer ring 30, valve 31, passage 61, ports 39 and 45 of the distributor valve into the rod end of the cylinder 6. When the pressure thus applied to piston 5 exceeds the combined forces urging the blades toward low pitch, the piston moves outwardly, and oil in the head end of the cylinder is displaced into the engine lubricating system. Its path is through tube 42 distributor valve ports 43 and 46, conduit 47, transfer ring 48, valve 50, and pump relief valve 25. The outward motion of the piston 5 is translated into rotary motion of the cam 7 which, through bevel gears increases the blade angle. This increase is accompanied by a decrease in engine speed and, because of decreased centrifugal force, the governor flyweights move inwardly under the action of the speeder spring, lowering the pilot valve 14 until, when the engine is again running at the speed for which the governor is set, the supply of governor oil to the propeller is completely shut off. Then, the output of the governor pump is discharged through the relief valve 24.

When the engine speed drops below the set value, the flyweights move inwardly, lowering the pilot valve and allowing oil from the rod end of the cylinder to flow back through the distributor valve into the governor, where it is discharged through a governor drain port which is then opened by the land 26. Under the action of centrifugal twisting movement and engine oil pressure, the blades now assume a lower angle, the engine speed increases, and the pilot valve rises due to the outward motion of the flyweights. When the engine has reached the speed for which the governor is set, the pilot valve again assumes a neutral position, neither admitting oil to nor draining it from the propeller cylinder. The forces are then in equilibrium and again the propeller runs at the selected speed.

To feather the propeller, it is only necessary to start the motor 71 by closing its control switch 73. The pump 70 supplies oil at a pressure substantially higher than the governor pump causing the piston 68 to move and close the valve 28 thereby disconnecting the governor. Simultaneously, the valve connects the high pressure oil conduit 66 to the conduit 27, permitting oil to flow to the rod end of the cylinder 6 as described above, causing the piston 5 and the cam rollers 7a to move under the increased pressure to the feathering or low mechanical advantage portion of the cam 7. Then the pressure builds up rapidly and this increase may be utilized to actuate means (not shown) for deenergizing the motor 71, the blades remaining feathered. During feathering, the position of the distributor valve is not changed, the pressure being insufficient to overcome the spring 53 which acts on the plunger 33.

To unfeather, the switch 73 is held closed and the pressure cut-out switch above referred to is prevented from operating. High pressure oil is again delivered to the rod end of the cylinder. As the pressure in the distributor valve increases, the plunger 33 moves against the spring 53 and above the feathering pressure the land 37 covers the port 45 disconnecting the supply line from the rod end of the cylinder 6. As the pressure rises to a predetermined higher value, the land 37 passes the port 45 thereby connecting the head end of the cylinder to the supply line 61 through ports 41 and 43, the rod end being connected to the low pressure line 47 through ports 45 and 46. Under this increased pressure, the piston 5 moves inwardly unfeathering the blades and forcing oil from the rod end of the cylinder into the lubricating system. Then, the blades begin to windmill. When a predetermined speed is attained, the control switch 73 is released, stopping the motor 71 and allowing the distributor and cut-off valves to return to their normal positions so as to transfer the control of the pitch actuator back to the governor.

To lock the blades in fixed position as during adjustment of the engine carburetor, it is only necessary to close the switches 64 and 73 with the engine running at a desired speed as determined by the governor speeder spring setting. The resulting energization of the solenoid 63 lifts

the rod 62 and changes the positions of the valves 29 and 50, the former disconnecting the governor from the regular supply line 27. The valve 50 not only disconnects the pumps 23 and 70 from the propeller servo through the normal supply lines, but also connects the outlet 70a of the feathering pump 70 to the conduit 49. With the parts thus positioned, oil from the pump 70 is delivered at a pressure determined by the setting of the relief valve 51 and somewhat higher than the lubricating oil pressure. The oil flows through the conduit 49 and the transfer ring 48 into the passage 47 and, since the line 61 is then closed by the valve 29, the pressure in the passage 47 rises sufficiently to move the piston 56, the valve plunger 31a thus being shifted against the action of the spring 55 to close the conduit 61 against the escape of oil from the distributor valve 32.

The oil pressure thus created by the pump 70 is applied to the head end of the servo piston through the conduit 47, ports 46, 43 of the distributor valve, and the conduit 42, this pressure supplementing the centrifugal moment tending to turn the blades toward low pitch. Such movement of the piston is prevented, however, because the passage leading to the rod end of the cylinder 6 through the distributor valve ports 45, 39 is blocked off or closed by the valve 31. It will be observed that the point of closure is in the rotating parts and between the distributor valve 32 and the transfer ring 30 so that there is no leakage from the cylinder 6. That is, oil is trapped effectively in the rod end of the cylinder and that portion of the conduits and distributor valve between the valve 31 and the cylinder. The oil, being non-compressible, provides in effect a positive stop preventing movement of the piston 5 toward the rod end of the cylinder thereby locking the propeller blades against movement toward low pitch. The combined centrifugal moment and the oil pressure acting on the piston 5 effectively holds the blades in the locked position during rotation of the propeller.

After the engine adjustments have been made, the switches 64 and 73 are opened. This stops the pump 70 and allows the valves 29 and 50 to be returned by the spring 74 to their normal positions restoring the regular governor control.

From the foregoing, it will be seen that the servo that normally adjusts the blades to maintain a constant engine speed is utilized to produce the force for locking the propeller blades in their limit positions. One of the fluid conduits leading to the servo is utilized to produce the hydraulic stop by which the limit position of the blades is determined. This stop is adjustable simply by running the engine at a speed corresponding to the fixed pitch desired preparatory to operating the valves 29 and 50 to disable the governor control and lock the blades at a fixed pitch. By using the valve 31 to trap oil in the rod end of the cylinder 6, the centrifugal force component acting on the blades assists in holding the latter in the locked position. This permits a low oil pressure to be employed for locking purposes.

I claim as my invention:

1. The combination of an engine having a low pressure lubricating system and a propeller driven by said engine and having blades tending to turn toward low pitch when the propeller is rotating, means including a piston movable in opposite directions to increase and decrease the pitch of said blades, a cylinder for said piston rotatable with said propeller, a first fluid conduit including a transfer ring between the rotating and non-rotating parts and connecting said lubricating system to one end of said cylinder whereby the low pressure fluid urges said blades toward low pitch, means providing a source of fluid at a pressure higher than said lubricating fluid pressure, a second fluid conduit extending through a second transfer ring to the other end of said cylinder, a valve responsive to the speed of said engine and controlling the flow of fluid from said second source to said second conduit, means providing a third source of pressure fluid, higher than said lubricating pressure and said second source of pressure, a normally open valve in said second conduit between said cylinder and said second transfer ring and adapted to close automatically in response to a fluid pressure in said first conduit higher than said lubricating pressure, and valve means in the non-rotatable portions of said conduits selectively operable to connect said lubricating and second pressure sources to said first and second conduits respectively in one position of the valve means to close said second conduit and connect said third pressure source to said first conduit in the other position of the valve means.

2. The combination of an hydraulic servo for adjusting the pitch of propeller blades including a double acting piston and cylinder, means for supplying fluid under pressure to one end of said cylinder, valve means operable in a plurality of different positions of said blades, and means automatically responsive to a predetermined pressure in said last mentioned cylinder end and independently of the blade positions to trap fluid in the other cylinder end and thereby lock the propeller blades at a fixed pitch.

3. The combination of a servo for adjusting the pitch of power driven propeller blades, means responsive to the speed of the propeller to control said servo and adjust said blades for the maintenance of a predetermined propeller speed, a normally inactive stop adapted when active to limit the adjustment of said blades by said servo, manually controllable means selectively operable to render said stop active in any one of a plurality of different positions of said blades, and means operable automatically as an incident to rendering said stop active to energize said servo independently of said speed responsive means and hold the blades against said stop.

4. The combination of an adjustable pitch propeller, an hydraulic servo rotatable with said propeller for actuating the same, means for supplying pressure fluid to said servo including fluid conduits leading through transfer rings to and from opposite ends of the servo, a pressure actuated valve disposed in one of said conduits between the transfer ring thereof and said servo and selectively operable in a plurality of different pitch settings of said propeller to open and close the conduit whereby to trap fluid in one end of said servo when the valve is closed and thereby lock the propeller against pitch adjustment, means rotatable with said propeller and automatically responsive to a built-up fluid pressure to actuate said valve and close the latter, and means operable selectively from a point exteriorly of said propeller and the parts rotating therewith to supply fluid under said built up pressure to said last mentioned means at a preselected one of said pitch settings and also to supply pressure fluid to the other end of said servo to urge

the propeller against the stop formed by said trapped fluid.

5. The combination with a hydraulic servo for adjusting the pitch of power driven propeller blades, means providing a source of fluid under pressure, means responsive to the rotational speed of the propeller blades and controlling the flow of said fluid to and from said source, a normally inactive stop adapted when rendered active to limit the adjustment of said blades by said servo, means providing a source of fluid under a pressure higher than said first mentioned pressure, and manually controllable means selectively operable to render said stop active at any selected one of a plurality of different positions of said blades to render said stop active and admit fluid from said second source to said servo to energize the latter and hold the blades against said stop.

6. The combination with a hydraulic servo for adjusting the pitch of power driven propeller blades, means providing a source of fluid under pressure, means responsive to the rotational speed of the propeller blades and controlling the flow of said fluid to and from said source, a normally inactive stop adapted when rendered active to limit the adjustment of said blades by said servo, means providing a source of fluid under a pressure higher than said first mentioned pressure, valve means responsive to the pressure of fluid from said source to render said stop effective, and manually controllable means selectively operable at any one of a plurality of different positions of said blades to disable said speed responsive means and energize said valve means from said second source.

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