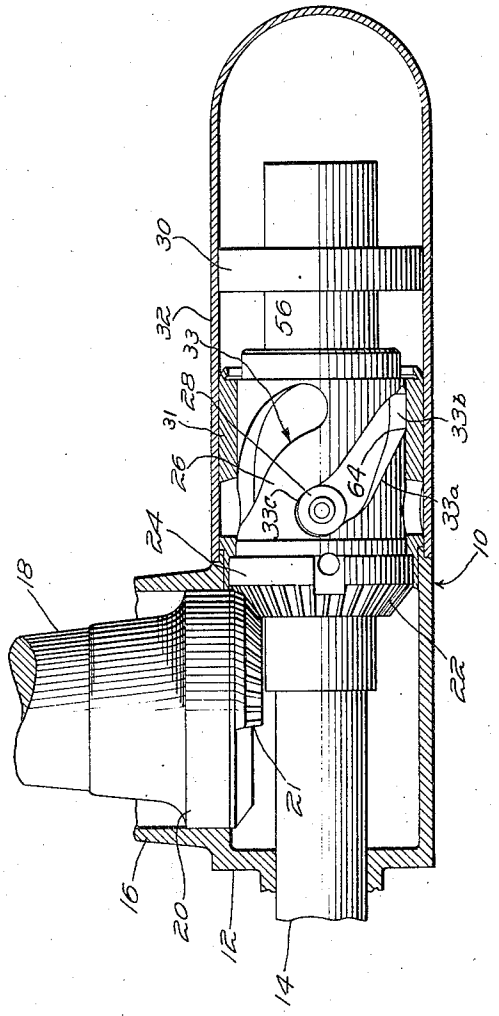
June 11, 1946. E. MARTIN 2,402,065

PROPELLER CONTROL

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Fig. 1.



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PROPELLER CONTROL

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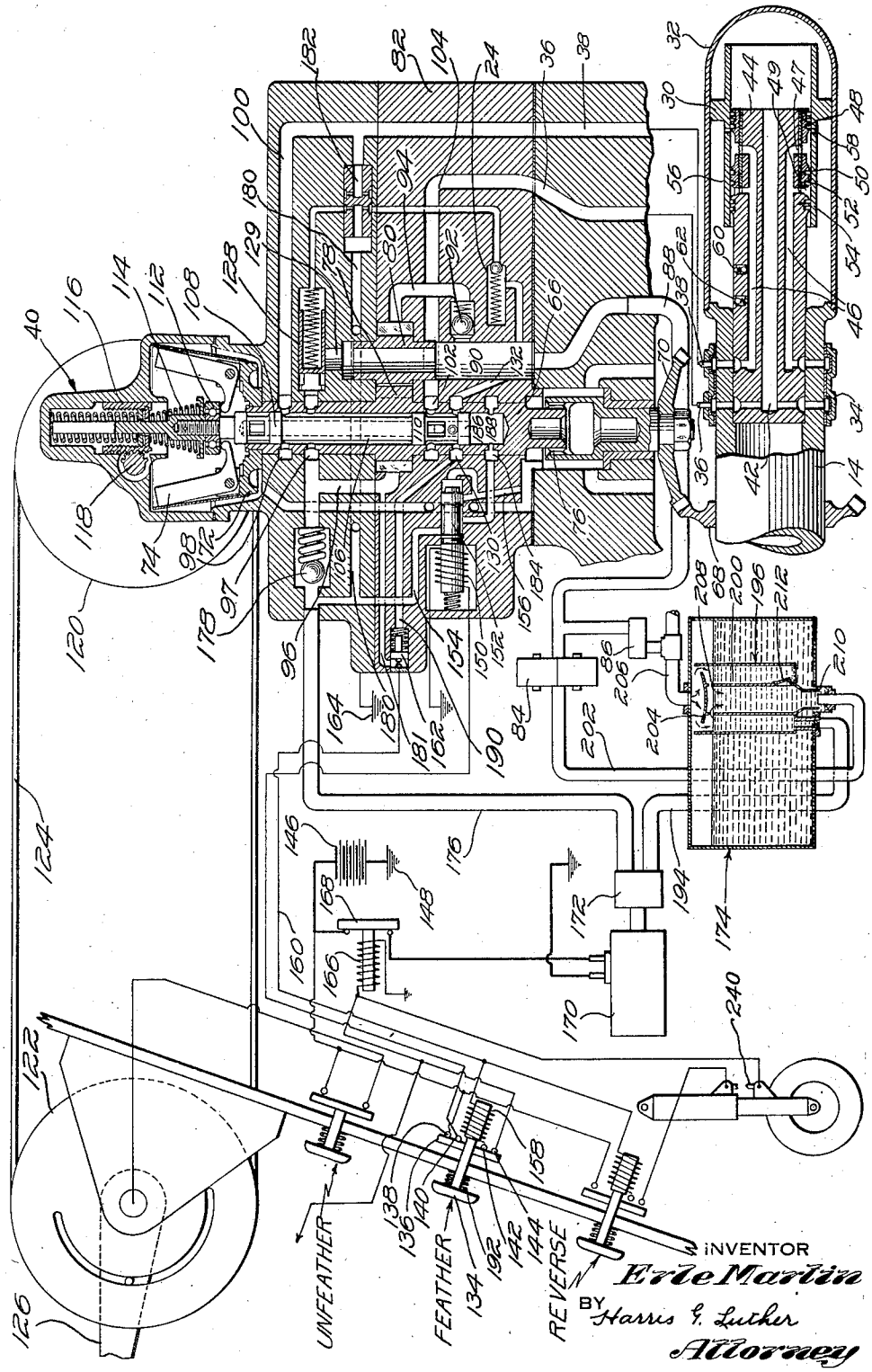


Fig. 2.

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PROPELLER CONTROL

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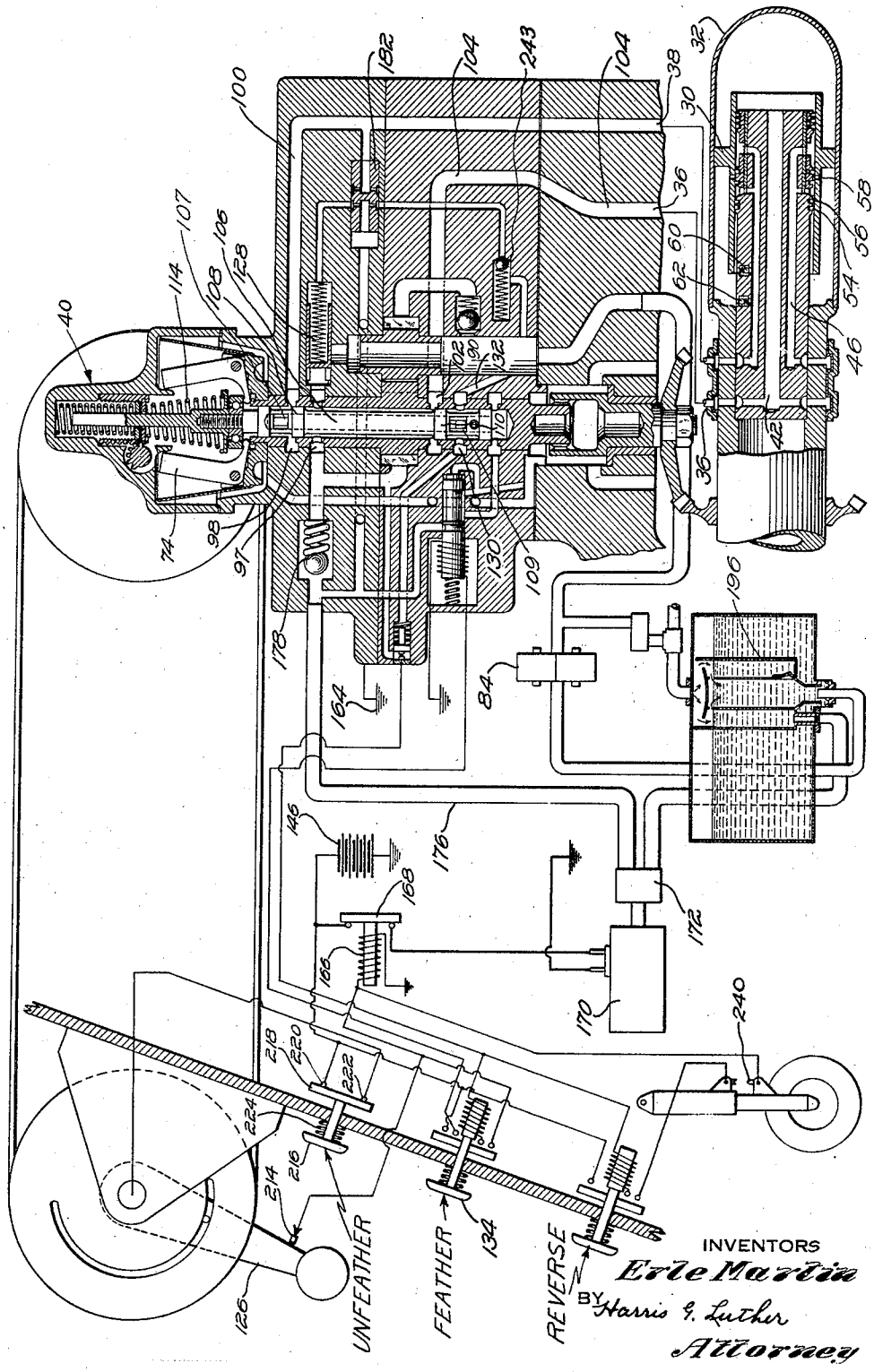


Fig. 3.

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PROPELLER CONTROL

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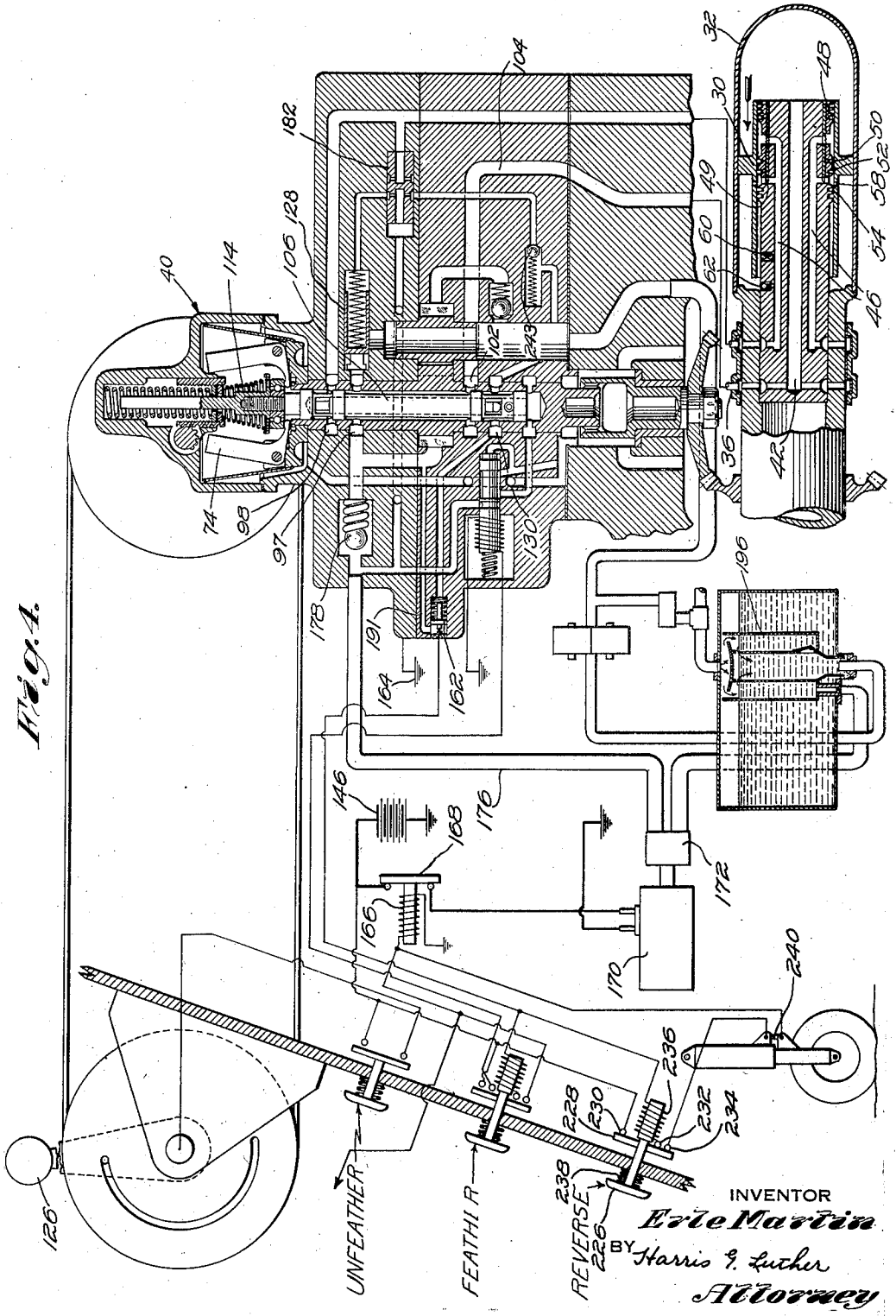


Fig. 4.

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UNITED STATES PATENT OFFICE

2,402,065

PROPELLER CONTROL

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27 Claims. (Cl. 244—81)

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This invention relates to reversible propeller and a control therefor, with particular reference to an improved feathering-type hydro-controllable propeller provided with reversing features and an improved control for operating the propeller in any of its various modes of operation.

An object of the invention is the provision of an improved propeller of the character indicated, including means for controlling the propeller pitch to maintain a substantially constant power plant speed, and pilot-controlled means for feathering, unfeathering and reversing the propeller.

A further object is the provision of a propeller and propeller control incorporating various safety features to avoid overspeeding of the power plant, by rendering it possible to unfeather the propeller only when the constant-speed control is set for a relatively low speed and to avoid reversing the propeller except when the propeller carrying airplane is on the ground.

Other objects and advantages will be apparent from the specification and claims and from the accompanying drawings which illustrate what is now considered to be a preferred embodiment of the invention.

In the drawings, Fig. 1 is a diagrammatic longitudinal sectional view through a propeller hub constructed according to the invention.

Fig. 2 is a diagrammatic view showing the propeller hub and the constant-speed control means in section and diagrammatically illustrating the remainder of the control means in position to feather the propeller.

Fig. 3 is a view similar to Fig. 2 showing the control means in position to unfeather the propeller, and

Fig. 4 is a diagrammatic view similar to Figs. 2 and 3 showing the control means in position to reverse the propeller.

Fig. 1 diagrammatically illustrates the principal elements of the improved controllable-pitch reversing type propeller. Such a propeller, as generally indicated at 10, may comprise a hub portion 12 mounted on a propeller drive shaft 14 and provided with a plurality of blade receiving sockets, such as the one indicated at 16. The propeller may have a plurality of blades mounted one in each socket, the blade for socket 16 being indicated at 18. The blades are so mounted as to be rotatable about their longitudinal axes in pitch changing directions and may be retained in the sockets by suitable anti-friction bearings, not illustrated, interposed between a socket abutment and a flange 20 on the blade end in a

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manner well known to the art. Each blade is provided on its end within the hub member 12 with a gear sector, as indicated at 21 for blade 18, all of which gear sectors mesh with a master gear 22 supported by the hub 12 and rotatable about the longitudinal axis of the hub. Gear 22 is mounted upon a rotatable member 24 rotated through a cam and follower mechanism, including movable cam rollers 26, 28 and fixed cam 31, by a piston 30 reciprocable in a cylinder 32 connected to the front end of hub 12 and having fluid connections to the opposite ends thereof as will presently appear. The movable cam generally indicated at 33, has a substantially straight intermediate portion 33*a* for constant-speed control, a steep pitch portion 33*b* at the high pitch end for feathering the propeller, and a steep pitch portion 33*c* at the low pitch end for reversing the propeller. The stationary cam 31 is similarly designed but slopes in the opposite direction.

The shaft 14 is rotatable in an oil transfer bearing 34 (Fig. 2) having two external fluid connections 36 and 38 leading from a governor mechanism, generally indicated at 40. The connection 36 leads through radial ports or apertures to a channel 42 (Figs. 2, 3, 4) extending forwardly through a member 44 which is an extension of shaft 14. An annular piston 30, in cylinder 32, has a tubular hub 56, mounted for reciprocation on shaft extension 44. Connection 38 leads through radial ports, and longitudinal channels 46 in member 44, to the exterior of member 44 through ports 47 between sealing rings 48 and 50 and ports 49 between rings 52 and 54. The tubular hub 56 of piston 30 is also provided with a ring of ports 58 through which fluid may pass. Fluid may also flow from channels 46 into the rearward end of the cylinder 32 through one or more check valves 60 arranged to open at a relatively low oil pressure, for example on a thirty-five pound pressure differential between the fluid in channels 46 and in the space between the piston and the rearward end of cylinder 32. Fluid at high pressure in the space rearward of the piston may flow to channels 46 through high pressure check valve 62 which prevents the flow of fluid from channels 46 to the cylinder space and also prevents flow of fluid from the cylinder space to channels 46 until the fluid in the cylinder space has reached a predetermined high pressure, for example, four hundred pounds per square inch above the pressure in channels 46.

When fluid is supplied under constant-speed control of the governor, through connection 36, the fluid will enter the space at the forward end

of cylinder 32 through channel 42 and force piston 30 rearwardly, and fluid from the space to the rear of the piston will be expelled through ports 58 and channels 46 to connection 38 which will be vented to the governor pump inlet. If the supply of oil to the front end of the cylinder is continued, the piston will move rearwardly until ports 58 are covered by seal ring 50 (Fig. 3) whereupon fluid will be trapped in the space to the rear of the piston and no further rearward movement of the piston can take place since the governor oil pressure is less than the four hundred pounds per square inch necessary to open check valve 62. The closure of port 58 by ring 50 thus constitutes a low pitch hydraulic limit stop which definitely predetermines the minimum pitch angle of the propeller blades as long as the propeller is functioning under governor control. When fluid under pressure is supplied through connections 38 and channels 46, as shown in Fig. 2, the fluid will enter the space to the rear of the piston through low pressure valve 60 and force the piston forwardly, while fluid in the front end of the cylinder will flow out through channel 42 and connection 36 which will be vented to governor pump inlet 90 by the governor at the same time that fluid under pressure is applied to the connection 38.

A high pitch limit stop for the governor controlled operation of the propeller may be provided in any one of several ways known to the art, for example, by changing the pitch of the cam which rotates the gear 22, such a change in cam pitch being indicated at 64 in Fig. 1, thereby increasing the resistance of the mechanism to further pitch change to such an extent that the resistance cannot be overcome by the hydraulic fluid at governor control pressure but may be overcome in order to increase the propeller pitch to a feathered condition by applying hydraulic fluid at an increased pressure to the space at the rear of the piston 30.

The propeller pitch changing mechanism, therefore, operates between definite predetermined lower and upper pitch limit stops as long as the mechanism is supplied with fluid at a pressure not exceeding a predetermined value used for constant speed control by the governor 40. But the pitch may be moved beyond either of the cam limit stops by the application of hydraulic fluid at a higher pressure sufficient to overcome the resistance of the change in the cam pitch to feather the propeller; or to unseat check valve 62 to reverse the pitch, in a manner which will presently appear.

The governor comprises a rotatable shaft 66 (Fig. 2) driven by engine driven gears as indicated at 68 and 70. Fast on the upper end of the shaft is a flange 72 pivotally supporting a pair of flyballs 74. Shaft 66 may be made in a single piece or, for convenience in construction and assembly may be made in several pieces connected together by suitable means such as the spline joint 76.

Shaft 66 carries intermediate its length, a gear 78 meshing with a gear 80 supported by a hollow axle in the governor base 82 to form a booster pump. Hydraulic fluid, such as engine lubricating oil, may be supplied to this pump from the engine lubricating oil system, which includes pump 84 and relief valve 86. Oil from pump 84 flows through channel 88 to chamber 90 from which it flows through check valve 92 to booster pump intake 94. Oil through the booster pump flows through passage 96 to the annular channel

97 connected with the interior of the shaft 66 through ports in the shaft. A second annular channel 98, above the channel 97, and likewise connected with the interior of shaft 66, is also connected through duct 100 with connection 38. Another annular channel 102, also connected with the interior of shaft 66, is connected by duct 104 with the transfer bearing connection 36.

Within the upper portion of hollow shaft 66 there is a hollow, vertically slidable, valve plunger 106 having spaced lands 108 and 110 controlling the ports leading to annular channels 98 and 102 respectively. At its upper end this plunger carries an anti-friction collar 112 interposed between the arms of the flyballs 74 and the end of the speeder spring 114 so that the position of plunger 106 is determined by the condition of balance between the rotatable flyballs and the speeder spring. The loading on the speeder spring may be adjusted by a slidable abutment 116 bearing against the upper end of the spring and positioned by a pinion 118 the teeth of which mesh with rack teeth on the abutment, the pinion being rotated manually by lever 126 through sheaves 120, 122 and cable 124.

Channel 97, in addition to being connected with pump outlet channel 96, is also connected with a relief valve 128 which regulates the pump outlet pressure by bypassing or venting some of the pump outlet fluid through channel 129 and the hollow axle of gear 80 to the fluid chamber 90 whenever the pump outlet pressure exceeds the predetermined value for which the valve 128 is set.

The mechanism thus far described will provide for complete constant-speed control of the propeller. In the case of an underspeed condition of the propeller, flyballs 74 will move inwardly and spring 114 will force plunger 106 downwardly until land 108 is below channel 98 (Fig. 3), thus connecting channel 98 with the governor pump inlet 90 through port 107, the hollow interior of plunger 106, port 109, and channels 130 and 132. At the same time land 110 will be moved below the ports leading to channel 102 thereby connecting channel 97 with channel 102. Under these conditions fluid under pressure will be supplied to the propeller through channel 104, connection 36 and channel 42 thus moving piston 30 rearwardly to decrease the pitch. At the same time the space to the rear of piston 30 will be connected with governor pump inlet 90 through channels 58, 47, 46, 38, 100, 98, 107, 109, 130 and 132.

If flyballs 74 move outwardly, due to an overspeed condition, plunger 106 will be lifted against the force of spring 114, and (as in Fig. 2) channel 98 will then be connected with channel 97 while channel 102 will be connected through channel 130 with pump inlet 90. Under these conditions fluid pressure will be supplied to the space at the rear of piston 30 through channels 98, 100, 38, 46 and check valve 60, while the space ahead of the piston will be vented through channel 42, connection 36 and channels 104, 102, 130 and 132 to chamber 90.

In feathering the propeller the governor valve plunger 106 is forced, as described below, to the position illustrated in Fig. 2. In order to accomplish the feathering operation, manual control button 134 is depressed, moving contactor 136 to interconnect switch terminal points 138, 140, 142 and 144. Switch point 138 is connected with one side of battery 146 the other side of which is connected with ground, as at 148. Connecting

switch point 140 with point 138 energizes solenoid 150 to move valve plunger 152 to open channel 154 to annular channel 184 and close off drain channel 156 therefrom. Connection of terminal 138 with terminal 142 energizes solenoid 158 surrounding an armature connected to button 134 to maintain the button in depressed condition as long as the battery circuit is not interrupted. The opposite side of solenoid 158 is connected through conduit 160 with a pressure actuated switch 162 the opposite side of which is connected with ground, as indicated at 164, so that opening and closing of switch 162 will control the energization of solenoid 158. Connection of terminal 138 with terminal 144 energizes solenoid 166 of the relay which operates switch 168 controlling energization of motor 170 which motor drives high pressure pump 172.

Pump 172 draws fluid from reservoir 174 and delivers it through conduit 176 to pressure channel 97. A check valve 178 is interposed in channel 176 so that pressure fluid from the governor booster pump will not feed back through the line 176 when pump 172 is not operating. High pressure fluid from pump 172 is also prevented from feeding back through the governor booster pump and relief valve 86 by check valve 92 interposed in the intake line 94 of the governor booster pump. Some of the pressure fluid from the line 176 is led through channel 180 and slide valve 182 to the space behind relief valve 128 so that this valve cannot act to relieve pressure in channel 97, and other fluid is led from line 176 through channel 154 and valve 152 to an annular channel 184 connected with the interior of shaft 66 below plunger 106, the lower end of which is closed and forms a piston 186, thus forming a chamber 188 in shaft 66 immediately below the plunger so that fluid introduced into the chamber from channel 184 will raise plunger 106 and maintain it in raised position, connecting channel 98 with channel 97, and channel 102 with channel 130 leading to the governor pump intake 90. Under these conditions fluid under pressure will be supplied to the propeller through channel 100, connection 38, channel 46 and check valve 60 to move piston 30 forwardly, thereby increasing the propeller pitch. As the output of pump 172 is of a sufficiently high pressure to overcome the high pitch limit stop 64 (Fig. 1) pump 172 will continue to operate until the propeller has reached its limiting high pitch or full-feathered condition. When piston 30 reaches the end of its stroke in a pitch increasing direction (Fig. 2), a pressure surge will occur in the fluid being supplied to cylinder 32 which pressure surge is communicated through channels 38, 100, 98, 97, 96 and 181 to the pressure actuated switch 162, causing it to interrupt the current through solenoid 158 thereby permitting spring 192 to move contactor 136 to an open circuit position. Thereupon the operation of pump 172 will cease and the valve plunger 152 will return to the position in which it closes channel 154 and opens drain channel 156 thus venting chamber 188 and restoring control of plunger 106 to flyballs 74 and speeder-spring 114 while leaving the propeller in its feathered condition.

None of the drawings illustrate the ports in position for constant speed operation. Figs. 2, 3 and 4 all show conditions in which the feathering pump 172 is delivering oil through conduit 176. Oil flowing through that conduit enters passage 180 and acts on slide valve 182 to move it to the position illustrated in Figs. 2, 3 and 4.

Under constant speed conditions, in which the feathering pump is inactive, pressure in passage 180 is relieved by leakage through pump 172 to tank 174, which is vented to atmosphere. This permits pressure from passage 100 to move valve 182 to the left, thus connecting channel 100 with high pressure relief valve 24 and unloading the valve 128 so that the latter can be backed up by the pressure existing in channel 100. Valve 128 opens at comparatively low pressure, therefore, in order to insure completion of the feathering, unfeathering and reversing operations it is necessary that it be backed up by pressure from pump 172.

In order to unfeather the propeller the governor control handle 126 is moved to the extreme low speed position, illustrated in Fig. 3 in which position the terminals of the switch 214 are brought into contact. Button 216 is then depressed, as also shown in Fig. 3, moving contactor 218 to interconnect switch terminals 220 and 222. Terminal 220 is connected with one side of battery 146, and terminal 222 is connected with relay solenoid 166 which operates contactor 168 controlling the energization of motor 170 of high pressure pump 172. The electric conduit from terminal 222 to solenoid 166 leads through switch 214 so that pump 172 cannot be operated to unfeather the propeller unless the governor speed control lever is in the low speed position indicated in Fig. 3.

Since the propeller does not rotate when in its feathered condition shaft 66 and flyballs 74 will not be rotating when the unfeathering operation is initiated and spring 114 will consequently hold plunger 106 in its lowermost position even though control lever 126 is moved to a position unloading spring 114 for low speed governor operation. The output of pump 172 will then flow through channel 176 and check valve 178 to pressure channel 97 and along plunger 106 to channel 102 from which it will be delivered through conduit 104, connection 36 and channel 42 to the front end of cylinder 32 to move piston 30 in a pitch decreasing direction, fluid at the rear of the piston passing through check valve 62.

As the propeller blades move out of their feathered condition the propeller will start to turn and will rotate governor shaft 66. As soon as the propeller speed comes up to the low speed setting of the governor, flyballs 74 will start to move the plunger 106 and the governor will take over control of the propeller pitch. If button 216 is maintained depressed after the governor control has been reestablished the only effect will be that the governor will operate the propeller with the high pressure oil from pump 172. As long as pump 172 is in operation the governor booster pump will build up a pressure equal to that produced in the governor lines by pump 172 since relief valve 128 will not be able to relieve the outlet pressure of the governor pump.

While maintaining button 216 depressed will not do any particular harm after the propeller starts to rotate, the pilot may watch his engine tachometer and release the button as soon as rotation of the propeller has been well established, as otherwise there will be an unnecessary waste of energy of battery 146, and an unnecessary period of subjecting the propeller and governor mechanism to high pressure fluid from pump 172. When button 216 is released spring 224 will move contactor 218 to a position disconnecting terminals 220 and 222 and thereby deenergizing the pump motor 170. As soon as pump

172 ceases to operate, check valve 178 will close off line 176 and slide valve 182 will be moved to the left in order to return control to the governor booster pump thereby reducing the pressure of the fluid in the governor and propeller.

The reversing operation is particularly illustrated in Fig. 4. This is accomplished by depressing button 226 causing contactor 228 to connect switch terminals 230, 232 and 234. Terminal 232 is connected with solenoid 236 which maintains button 226 depressed against the force of spring 238, and the connection from the opposite end of the solenoid leads through pressure actuated switch 162 to ground 164 so that solenoid 236 may be deenergized upon actuation of switch 162. Terminal 234 leads to relay solenoid 166, controlling switch 168 of motor 170 through a switch 240 carried by the landing gear and so arranged that its elements are in contact only when the landing gear is lowered to landing position and loaded by the weight of the airplane. Thus motor 170 cannot be operated to reverse the propeller while the airplane is in flight.

In the case of a seaplane switch 240 may be some form of hydrostatic switch closed only when the seaplane is on the water.

With button 226 depressed and switch 240 closed motor 170 will drive pump 172 to deliver fluid under high pressure through conduit 176 and check valve 178 to pressure channel 97. However, before the propeller can be reversed the manual control lever 126 for setting the governor must be moved to the high speed position indicated in Fig. 4 in order to compress spring 114 to move plunger 106 downwardly, and the engine throttle must be retarded to a position at which flyballs 74 do not exert sufficient force to overcome the force of the spring and raise the plunger. If desired, an additional safety feature may be incorporated by placing a switch on the engine throttle in series with switch 240 so that motor 170 cannot be operated to reverse the propeller unless the throttle is retarded past a predetermined setting.

With plunger 106 held in its lowermost position, as indicated above, high pressure fluid from channel 97 will flow to channel 102 and thence through channel 104 to transfer bearing connection 36 and then through propeller channel 42 to the front end of cylinder 32 to move piston 30 rearwardly in a pitch decreasing direction. The piston will move easily as long as ports 58 are uncovered but, when the piston has moved rearwardly until these ports are covered by the ring 50, fluid will be trapped in the cylinder space at the rear of the piston, and the hydraulic low pitch limit stop will become effective to resist further decrease in the propeller pitch. Since pump 172 produces a pressure greater than that necessary to open check valve 62, continued operation of the pump will open this valve and permit the fluid trapped in the rear cylinder space to exhaust through valve 62 thus permitting piston 30 to override the low pitch limit stop. Once the ports have passed ring 50, however, the fluid trapped in the rearward cylinder space will be vented through auxiliary channels 49 leading to channels 46 and the resistance imposed by the valve in the port 62 will be removed. Under these conditions, pump motor switch 168 is closed, check valve 178 is open and the slide valve 182 is in its right hand position to apply the fluid pressure at the outlet of pump 172 to the rear of relief valve 128.

A positive low pitch limit stop is provided to

determine the full reverse pitch of the propeller. With the governor control lever 126 in the high governor speed position indicated above and the engine throttle retarded before the reversing operation is initiated, the propeller will be in its limiting low pitch condition when the reversing operation is begun so that the operation actually starts with ports 58 covered by ring 50. As the piston 30 moves rearwardly from this position and passes relief port 49 and comes to a position in which port 58 is covered by ring 54 a pressure surge will be established in the fluid between pump 172 and the propeller, which will operate through channel 191 to open switch 162 to deenergize solenoid 236, thereby permitting button 226 to move outwardly under the force of spring 238 to move contactor 228 to disconnect terminals 230, 232 and 234 thereby discontinuing operation of pump 172 with the propeller in reverse pitch.

The propeller may be gotten out of the reverse pitch condition by moving governor speed control lever 126 to a low governor speed position and then opening the engine throttle sufficiently to create a sufficient flyball force to move plunger 106 to connect channel 97 with channel 98, and connect channel 102 with drain channel 130.

A safety valve 243 is connected with the space at the back of relief valve 128 in order to permit valve 128 to open and relieve the pressure produced by either of the pumps if such pump pressure tends to exceed a predetermined safe limiting value.

Oil reservoir 174 contains an auxiliary tank 196 through which oil circulates rapidly in order to always have available, (under normal operating conditions) a supply of warm, free flowing oil for such operations as feathering the propeller. Oil returning through engine drain 206 lands on a saucer 204 within reservoir 174 and spills over the rim thereof into tank 196. Within tank 196 is a hopper 200 into which oil overflows at 208.

Engine lubricating oil is drawn by pump 84 through pipe 202 the suction end of which is connected to sump 210, into which oil feeds directly from hopper 200, and indirectly from main reservoir 174 from which oil enters the sump around the lower end of the hopper.

Oil for feathering the propeller is drawn by pump 172 through suction pipe 194 connected to the bottom of auxiliary tank 196, therefore always drawing warm oil just returned from the engine lubricating system. A check valve 212 allows warm oil to flow automatically from hopper 200 into tank 196 if additional warm oil is needed therein.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. In the combination of a controllable-pitch propeller having a hydraulic pitch changing motor and a propeller control including a speed governor, means for supplying hydraulic fluid at pressures within a predetermined range for governor control of said propeller, and means for supplying fluid at pressures above said predetermined range for feathering, unfeathering and reversing said propeller, a releasable limit stop restraining said motor against changing the propeller pitch below a predetermined pitch angle while said motor is operated by fluid at pressures within said predetermined pressure range, means rendering said limit stop ineffective to limit the pitch

changing movements of said motor when fluid at a pressure above said predetermined range is applied to said motor, manually operable means controlling said high pressure fluid supply means for applying to said propeller fluid at a pressure sufficient to render said limit stop ineffective and operate said motor to decrease the propeller pitch below said low pitch limit stop, a positive low pitch limit stop effective to terminate the pitch decreasing operation of said motor, and means, actuated upon the termination of motor operation and operatively connected with said high pressure fluid supply means, for discontinuing the operation of said high pressure fluid supply means when the propeller pitch is reduced to an angle determined by said low pitch limit stop.

2. In the combination of a controllable-pitch propeller having a hydraulic pitch changing motor and a propeller control including a speed governor, means for supplying hydraulic fluid at pressures within a predetermined pressure range for governor control of said propeller, and means for supplying fluid at pressures above said predetermined pressure range for feathering, unfeathering and reversing said propeller, a releasable limit stop restraining said motor against changing the propeller pitch below a predetermined pitch angle while said motor is operated by fluid at pressures within said predetermined pressure range, means rendering said limit stop ineffective to limit the pitch changing movements of said motor when fluid at a pressure above said predetermined range is applied to said motor, manually operable means for controlling said high pressure fluid supply means for applying to said propeller fluid at a pressure sufficient to render said limit stop ineffective to limit the pitch changing movements of said motor and decrease the propeller pitch below said low pitch limit stop, an airplane landing gear, and means carried by said landing gear and operatively connected with said high pressure fluid supply means to prevent operation of said high pressure fluid supply means except when said landing gear is extended and loaded.

3. In the combination of a controllable-pitch propeller having a hydraulic pitch changing motor and a propeller control including a speed governor, means for supplying hydraulic fluid at pressures within a predetermined pressure range for governor controlled operation of said propeller, and an electric motor driven pump for supplying hydraulic fluid to said motor at pressures above said predetermined pressure range for feathering, unfeathering and reversing said propeller, a releasable limit stop operatively associated with said motor for restraining said motor against changing the propeller pitch below a predetermined pitch angle while said motor is operated by fluid at pressures within said predetermined pressure range, means rendering said limit stop ineffective to limit the pitch changing movements of said motor when motor operating fluid at a pressure above said predetermined pressure range is applied to said motor, a manually operable switch operatively connected with said electric motor driven pump to control the operation thereof, a spring urging said switch to open position, a solenoid acting against the force of said spring when energized to maintain said switch closed, and a pressure switch subject to the pressure of the fluid supplied to said motor and connected in series with said solenoid to de-energize said solenoid when said motor reaches the end of its pitch reducing stroke.

4. The arrangement as set forth in claim 3 including an airplane landing gear and a switch mounted on said landing gear and connected in series between said manually operable switch and said motor driven pump to prevent actuation of said pump by said manually operable switch except when said landing gear is extended and loaded.

5. In combination with a controllable-pitch propeller having a hydraulic pitch changing motor and means for supplying high pressure fluid to said motor to turn the propeller blades to a reverse pitch position, a fluid connection between said fluid supply means and said motor, a speed governor, and a valve operated by said governor and interposed in said fluid connection to render said motor ineffective to turn the propeller blades to a reverse pitch position except when the rotational speed of said propeller is below the speed setting of said governor.

6. In combination, a propeller, a hydraulic double acting propeller pitch changing motor therefor, a first source of fluid under pressure, a speed responsive governor actuated valve controlling the application of said fluid to said motor, stops limiting the extent of movement of said motor under the influence of said fluid, a second source of fluid under pressure higher than said first fluid pressure, means leading fluid at said higher pressure to said governor actuated valve, manually controlled means for moving said valve to direct said higher fluid pressure to either selected side of said motor to render the respective limit stop ineffective and either feather or reverse said propeller, said valve moving means comprising mechanism for directing fluid to one end of said valve for moving it in one direction and mechanism for compressing the governor spring to move the valve in the other direction.

7. In combination, a double acting fluid actuated propeller pitch changing motor, a source of fluid under pressure, a valve, speed responsive means actuating said valve to selectively direct said fluid under pressure to either side of said motor, manually controlled means, including mechanism for selecting the governor speed setting, for moving said valve to one extreme position, a second manually controlled means for energizing a source of fluid at a higher pressure, conduits leading to said fluid at said higher pressure to said valve, and means controlled by said valve moving means for preventing energization of said source of fluid at said higher pressure by said second manually controlled means except when said speed selecting means is in its low speed position.

8. In combination, a fluid actuated propeller pitch changing motor, a source of fluid under pressure, a governor controlled valve for directing said fluid under pressure to said motor, a piston operatively connected with said valve, another valve having a fluid connection with said piston, a drain connection, manually controlled means for substantially simultaneously applying fluid at a higher pressure to said governor controlled valve and moving said governor controlled valve to an extreme position to connect said higher pressure fluid to a selected side of said motor, including means for moving said another valve to disconnect said piston from said drain connection and to connect said piston with said higher pressure fluid to thereby move said governor valve to its extreme position.

9. In combination a fluid actuated propeller pitch changing motor, a source of fluid under

pressure, a relief valve for controlling the pressure of said fluid, a governor controlled valve for directing said fluid under pressure to said motor, a source of fluid, at a higher pressure, a relief valve set for a pressure higher than said first mentioned relief valve, a piston operatively connected with said governor controlling valve, another valve having a fluid connection with said piston, a drain connection, manually controlled means for substantially simultaneously applying fluid at said higher pressure to said governor controlled valve and moving said governor controlled valve to an extreme position to connect said higher pressure fluid to a selected side of said motor, including means for moving said another valve to disconnect said piston from said drain connection and connect said piston with said higher pressure fluid to thereby move said governor valve to its extreme position including means for rendering said first mentioned relief valve inoperative and connecting in said relief valve set for a higher pressure.

10. In combination with a fluid actuated motor, fluid supply means connected to said motor for supplying fluid under pressure thereto, a pressure relief valve connected with said supply means for limiting the pressure developed by said supply means, a governor actuated valve interposed between said fluid supply means and said motor controlling the application of said fluid to said motor, and manually controlled means for rendering said governor actuated valve ineffective and applying hydraulic fluid to said motor until it reaches a limiting position, said manually controlled means including, a pump for supplying fluid at a high pressure above the output pressure of said fluid supply means, means actuated by said high pressure fluid to maintain said relief valve closed, and means actuated by said high pressure fluid for maintaining said governor actuated valve in a limiting position in which it maintains an open connection between one side of said motor and said pump and an open drain leading from the opposite side of said motor.

11. In combination with a fluid actuated motor, a first pump for applying fluid under pressure to said motor, a relief valve for said pump, a governor actuated valve for controlling the application of said fluid to said motor, and manually controlled means for operating said motor comprising, a second pump delivering fluid at a pressure above the pressure setting of said relief valve, means operated by the fluid pressure from said second pump maintaining said relief valve closed, means operated by the fluid pressure from said second pump maintaining said governor actuated valve in a limiting position in which it maintains an open connection between the outlets of said pumps and one end of said motor and an open drain connection from the opposite end of said motor, and a high pressure safety valve connected with the outlets of said pumps.

12. The invention set forth in claim 13 in which said preventing means is under control of the airplane pilot.

13. A control for a feathering and unfeathering propeller comprising, means for regulating the speed of said propeller including a governor having a range of speed settings and having a low speed setting at one end of said range energizable means for unfeathering said propeller and means controlled by said speed regulating means for preventing energization of said unfeathering means except when said governor is set in its low speed setting.

14. In a propeller pitch control, a double acting hydraulic pitch changing motor, a pump for supplying fluid under pressure, two fluid pressure lines, one leading to one side of said motor and the other leading to the other side of said motor, a speed-governor-actuated valve selectively connecting said pump with one or the other of said lines, a pressure relief valve connected with said pump for controlling the pressure developed by said pump, resilient means urging said valve to closed position, a channel connecting the rear of said relief valve with said one pressure line whereby the fluid pressure in said one pressure line assists said resilient means in urging said valve to closed position.

15. In a propeller pitch control, a double acting hydraulic pitch changing motor, a first pump for supplying fluid under pressure, a booster pump for boosting the pressure developed by said first pump, two fluid pressure lines, one leading to one side of said motor and the other leading to the other side of said motor, a speed governor actuated valve selectively connecting said first pump with said one line and said booster pump with said other line or reversing the connections between said pumps and said lines, a pressure relief valve connected with said booster pump for controlling the pressure developed by said booster pump, resilient means urging said valve to closed position, a channel connecting the rear of said relief valve with said one pressure line whereby the fluid pressure in said one pressure line assists said resilient means in urging said valve to closed position.

16. In a control for a hydro-controllable propeller, a hydraulic pitch changing motor, a pump for supplying fluid under pressure, a fluid connection between said pump and said motor, a speed governor, a valve, actuated by said governor, intercepting said connection, and operative to connect said motor with said pump or with a vent, a pressure relief valve for said pump, a first fluid channel connecting said relief valve with the portion of said fluid connection between said governor operated valve and said pitch changing motor to apply the pressure entering or leaving said motor to said relief valve to urge said relief valve to closed position, resilient means urging said relief valve to closed position, a valve in said channel urged by the pressure of fluid in said fluid connection to a position to maintain said channel open, and means for moving said last-mentioned valve to another position to block said channel and modify the action of said relief valve.

17. In a control for a hydro-controllable propeller, a hydraulic pitch changing motor, a pump for supplying fluid under pressure, a fluid connection between said pump and said motor, a speed governor, a valve actuated by said governor, intercepting said connection, and operative to connect said motor with said pump or with a vent, a pressure relief valve for said pump, a first fluid channel connecting said relief valve with the portion of said fluid connection between said governor operated valve and said pitch changing motor to apply the pressure entering or leaving said motor to said relief valve to urge said relief valve to closed position, resilient means urging said relief valve to closed position, a source of fluid under pressure, a second channel connecting said source of fluid pressure with said relief valve to urge said relief valve to closed position, a valve in both said channels urged by the pressure of fluid in said first fluid connection

to a position to maintain said first fluid channel open and block said second fluid channel and urged by pressure of said second source of fluid pressure to a position to maintain said second fluid channel open and block said first fluid channel.

18. In a propeller pitch control, a double acting hydraulic pitch changing motor, a first pump for supplying fluid under pressure, a booster pump for boosting the pressure developed by said first pump, two fluid pressure lines, one leading to one side of said motor and the other leading to the other side of said motor, a speed governor actuated valve selectively connecting said first pump with said one line and said booster pump with said other line or reversing the connections between said pumps and said lines, a pressure relief valve connected with said booster pump for controlling the pressure developed by said booster pump, resilient means urging said valve to closed position, a channel connecting the rear of said relief valve with said one pressure line whereby the fluid pressure in said one pressure line assists said resilient means in urging said valve to closed position, a slide valve in said channel urged by the pressure in said pressure line to a position to maintain said channel open, a third pump for supplying fluid under pressure, means connecting the outlet of said third pump with the outlet of said booster pump, a second channel interrupted by said slide valve and connecting the outlet of said third pump with the rear of said relief valve, said slide valve being urged by the pressure of the third pump to a position to open said second channel and block said first channel.

19. In combination, a propeller, a hydraulic pitch-changing motor therefor, a first source of fluid under pressure, a speed-responsive-governor-actuated valve controlling the application of said fluid to said motor, stops limiting the extent of movement of said motor under the influence of said fluid, a second source of fluid under pressure higher than said first fluid pressure, means leading fluid at said higher pressure to said governor actuated valve, manually controlled means for moving said valve to direct said higher fluid pressure to one side of said motor to render the limit stops ineffective and feather said propeller, said valve moving means comprising mechanism for directing fluid to one end of said valve for moving it.

20. In combination, a propeller, a hydraulic pitch-changing motor therefor, a first source of fluid under pressure, a speed-responsive-governor-actuated valve controlling the application of said fluid to said motor, a second source of fluid under pressure, means leading fluid from said second source to said governor-actuated valve, mechanism for directing fluid from said second source to a piston operatively connected with one end of said governor-actuated valve to move said valve and render said governor ineffective to actuate said valve, said valve when moved by said piston directing fluid from said second source to one side of said motor.

21. A device as claimed in claim 20 in which said second source of fluid under pressure is electrically controlled and said mechanism for directing fluid to said piston includes an electrically controlled valve.

22. A device as claimed in claim 20 in which said second source of fluid under pressure comprises an electrically driven pump and said mechanism for directing fluid to said piston includes a solenoid operated valve.

23. A device as claimed in claim 20 including an electrically driven pump for providing said second source of fluid under pressure, a solenoid operated valve for directing fluid to said piston and a common switch for simultaneously connecting said electrically driven pump and said solenoid with a source of electricity.

24. In combination, a propeller, a hydraulic double-acting pitch-changing motor therefor, a first source of fluid under pressure, a speed-responsive-governor-actuated valve controlling the application of said fluid to said motor, a second source of fluid under pressure, means leading fluid from said second source to said governor actuated valve, manually controlled means for moving said valve to direct fluid from said second source to either selected side of said motor to either feather or unfeather said propeller, said valve moving means comprising mechanism for directing fluid from said second source to a piston operatively connected with said valve for moving it in one direction, other means for moving said valve in the other direction.

25. A device as claimed in claim 24 including a pump actuated by rotation of said propeller providing said first source of fluid under pressure and in which said second source of fluid under pressure is independent of rotation of said propeller.

26. A device as claimed in claim 24 in which the other means for moving the governor actuated valve in the other direction includes mechanism for compressing the governor spring to move the valve.

27. In combination, a double-acting fluid-actuated propeller pitch changing motor, a source of fluid under pressure, a valve, speed responsive means, including a speeder spring, actuating said valve to selectively direct said fluid under pressure to either side of said motor, a movable speeder spring abutment, manually controlled means for selecting the governor speed setting, including means for moving said abutment to a predetermined position to set the governor at a low speed setting, a second manually controlled means for energizing a source of fluid at a higher pressure, conduits leading said fluid at said higher pressure to said valve, and means controlled by said first mentioned manually controlled means for permitting energization of said source of fluid at said higher pressure by said second manually controlled means only when said abutment is in substantially said predetermined position.

ERLE MARTIN.

Certificate of Correction

Patent No. 2,402,065. June 11, 1946.

ERLE MARTIN

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 10, line 50, claim 7, strike out "to"; and column 11, line 7, claim 9, for "controlling" read *controlled*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of October, A. D. 1946.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.