

Dec. 18, 1951

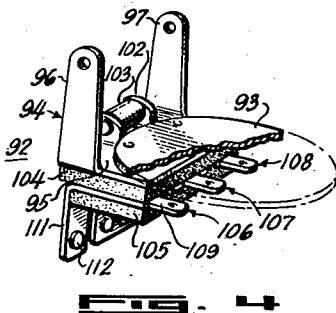
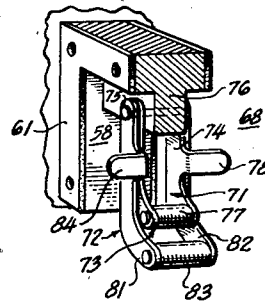
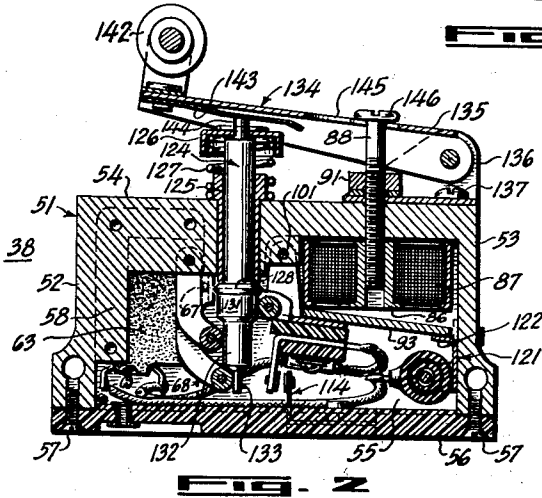
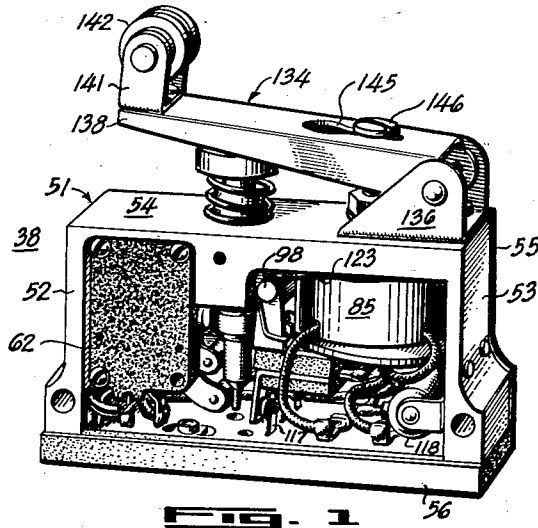
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2,579,172

PROPELLER PITCH REVERSING CONTROL SWITCH

Filed March 31, 1949

2 SHEETS—SHEET 1



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2 SHEETS—SHEET 2

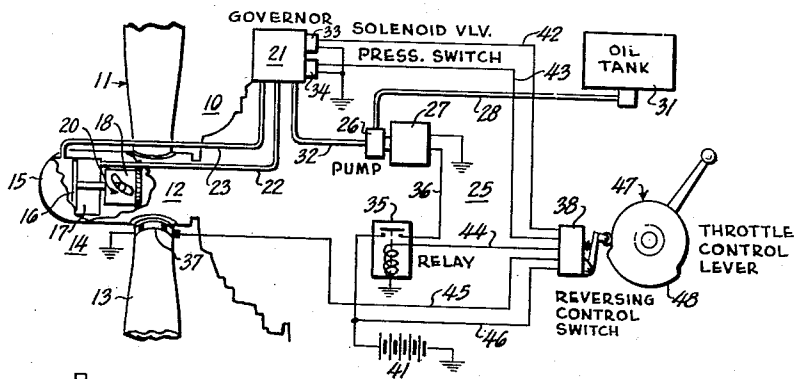


FIG. 5

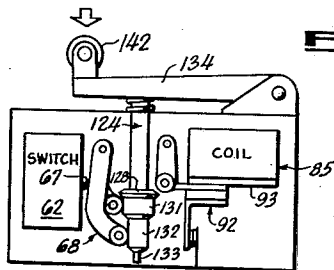


FIG. 6

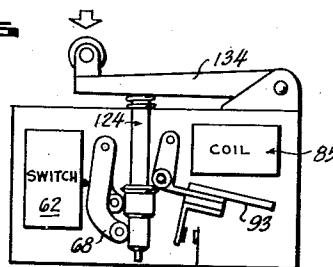


FIG. 7

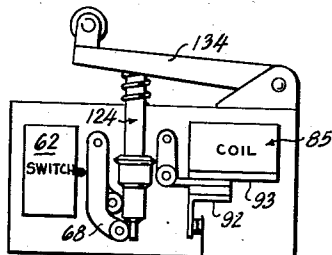


FIG. 8

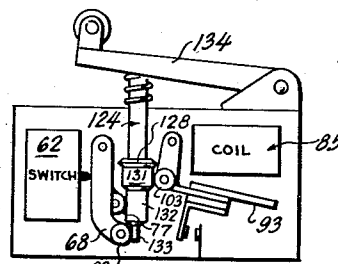


FIG. 9

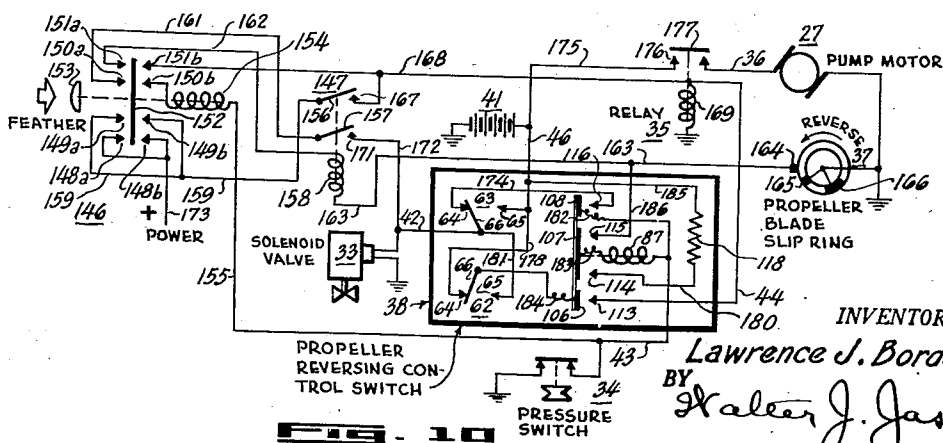


FIG. 10

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PROPELLER PITCH REVERSING CONTROL SWITCH

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11 Claims. (Cl. 200—153)

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This invention relates to hydraulically actuable controllable pitch propellers and more particularly to improved control means for effecting the operation of a propeller of the character indicated.

An object of the present invention resides in the provision of a propeller pitch control system having control devices for attaining pitch reversal of the propeller blades.

Another object of this invention is to provide an electrical control instrumentality of improved construction operative to control the movements of the blades of a hydraulically actuated propeller into and out of reverse pitch positions.

Another object of the invention resides in providing a control instrumentality of the character indicated having the operation thereof under the control of the usual engine throttle lever.

Another object of the invention lies in providing an electrical control instrumentality embodying a plurality of electric switch units and electromagnetic switch means electrically associated and all being operative by a common actuating means.

A further object of the invention is the provision of an electrical control instrumentality for controlling the operation of a reversing type hydraulically actuable propeller which is of simple, compact and efficient construction.

Other objects and features of the present invention will be readily apparent to those skilled in the art from the following specification and appended drawings wherein is illustrated a preferred form of the invention, and in which:

Figure 1 is a perspective view of an electric control instrumentality in accordance with the invention.

Figure 2 is a vertical sectional view through the instrumentality.

Figure 3 is a detail view in perspective illustrating the actuator arrangement for the electric switch units of the instrumentality.

Figure 4 is a detail view in perspective showing an armature and associated movable contact assembly for use in the electric control instrumentality of Figure 1.

Figure 5 is a diagrammatic view showing a hydraulically actuated controllable pitch propeller and a pitch reversing control system associated therewith.

Figure 6 is a diagrammatic illustration of the electrical control instrumentality showing the relative positions of the various operating elements for moving the propeller into reverse pitch position.

Figure 7 is a view similar to Figure 6 but with

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the operating elements illustrated in the relative positions assumed when the propeller is being maintained in reverse pitch position.

Figure 8 is another diagrammatic view of the electrical control instrumentality showing the positions of the operating elements when the propeller is being moved from reverse pitch to normal position.

Figure 9 is a diagrammatic view showing the static positions of the operating elements of the electrical control instrumentality; and

Figure 10 is a wiring diagram of the reverse pitch control circuit shown in association with the feathering control wiring circuit for the propeller.

Particular reference is now directed first to Figure 5, wherein is shown an aircraft power plant comprising an internal combustion engine, generally indicated at 10, which engine 10 is equipped with a hydraulically actuable controllable pitch propeller 11. Propeller 11 has a propeller hub 12 to which is movably secured a plurality of propeller blades 13 adapted to rotate about their longitudinal axes to change their pitch angle or angle of attack. Suitable hydraulic pitch changing mechanism, indicated generally at 14, is contained within a dome 15 and includes a piston 16 reciprocable in a cylinder 17. Piston 16 is made to move within its containing cylinder 17 by the force exerted by hydraulic fluid supplied under pressure to the opposite ends of the cylinder 17. Piston 16 is suitably operatively connected to the propeller blades 13 through a rotatable member 18 carrying gear means 19 which are adapted to mesh with usual beveled gear means (not shown) provided on the inner or base ends of the propeller blades 13. The piston 16 is joined to the rotatable member 18 through a cam follower-cam track arrangement 20 for effecting rotation of member 18 upon reciprocating movement of the piston 16. This organization of elements acts to convert reciprocable movement of piston 16 into rotative, pitch changing movement of the propeller blades 13. For a more detailed description of the arrangement of the propeller blades and the operative connection thereto of the actuating mechanism reference may be had to United States Patent No. 2,361,954, issued November 7, 1944 for Propeller Control Means.

A suitable governor 21 conveniently mounted on the engine 10 acts to supply fluid to pitch changing mechanism 14 to automatically effect adjustments in propeller blade pitch necessary to maintain constant engine speed under varying flight conditions. The fluid provided by the

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governor 21 to the pitch changing mechanism 14 for automatic operation of the latter is taken, as is normal, from the usual engine lubricating system through a conduit (not shown). A conduit 22 connects the governor 21 to the space at the pitch reducing end of piston 16 while a second conduit 23 permits fluid to be passed to the space at the pitch increasing side of piston 16. Oil will be directed to either side of the piston 16 by the governor 21 as required by flight conditions. During an underspeed condition of the engine the governor 21 is adapted to operate to pass oil through conduit 22 to the inboard side of piston 16 to provide pressure to cause the propeller blades 13 to move to a lower pitch whereupon engine speed increases. With an overspeed condition the governor 21 will respond to direct oil through conduit 23 to the outboard side of piston 16 to cause propeller blades 13 to move to a higher pitch, thereby decreasing the engine speed. The particular construction of the governor 21, it is understood, forms no part of the present invention as it is contemplated that such usual governors may be employed as are adapted, in response to external conditions, to cause fluid to be passed to one or the other of the two conduits 22 and 23 connected to the pitch changing mechanism 14. The governor 21 may conveniently assume the form and construction as fully described in a manual entitled Propeller Hydromatic Governors No. 123, published by Hamilton Standard Propellers of East Hartford, Connecticut. Associated with governor 21 and the controllable pitch propeller 11 is a control system, indicated generally by the numeral 25, which is adapted to accomplish movement of the propeller blades 13 from their normal range to their reverse pitch positions. Positioning of the propeller blades 13 in reverse pitch serves a primary desirable function in reducing airplane landing speeds and runs. The attainment of this condition must be rapid, efficient and certain and the control system 25 provided by this invention is all this.

The control system 25, as shown, includes a suitable gear type pump 26 driven by an electric motor 27. It is here noted that this pump 26 used in the reversing operation is the same pump which is used for the feathering operation, so the reversing operation does not require a separate pump. A fluid line 28 connects the inlet of pump 26 with the sump of the oil tank 31 which may be the source of supply for the engine lubrication system. The pump 26 is connected through a conduit 32 to the governor 21 whereby auxiliary oil is supplied to the governor 21 to supplement the normal oil output of the governor, which supplemented oil output is directed by the governor to the pitch control mechanism 14 for use thereby during feathering, unfeathering, reversing and unreversing operations of the propeller blades 13.

Associated with the governor 21 and adapted to affect the oil supplying operations thereof are a solenoid valve member 33 and a pressure switch 34. The solenoid valve 33 is of a suitable construction adapting it to direct the flow of high pressure auxiliary oil from conduit 32 so that it, in a manner well known in the art, supplements the pressure of the normal oil provided by the governor 21 on either the inboard or the outboard side of the piston 16 as required to change the angle of the propeller blades 13. The pressure switch 34 is provided to stop the operation of the pump 26 when the oil pressure in propeller cylinder 17 builds up to a predetermined value. The pressure switch 34 is operatively connected to

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the propeller governor 21 so that the oil pressure differential across the propeller piston 16 is duplicated in the pressure switch 34, thus when the oil pressure in cylinder 17 builds up to the cut-out value of switch 34 after the completion of either a propeller feathering or a propeller reversing operation the switch breaks the electrical circuit to the motor 27 of pump 26, in a manner and through the use of various mechanisms to be hereinafter described in detail, to close off the auxiliary pressure being provided to the piston 16 and return the pitch changing mechanism to the normal control of governor 21.

A usual relay 35, electrically connected to the electric motor 27 through a conductor 36, directly controls the flow of current to the motor 27 for energization and deenergization thereof.

Carried by a propeller blade 13 is a slip ring 37 of usual construction, which slip ring is connected to an electrical instrumentality or propeller reversing control switch 38. The slip ring 37 serves to disrupt the current supply to the feather relay to deenergize the feather pump motor 27 to shut off the flow of auxiliary oil from pump 26 when the propeller blades 13 have returned to positive pitch after an unreversing operation has occurred. This operation will be described in complete detail hereinafter.

A battery 41, or any other primary current supply source, is provided to supply the power for use in the operation of the control system 25.

The propeller reversing control switch 38 constitutes the primary control member in the control system 25 in that it controls the flow of current from the battery 41 into the system. The solenoid valve 33, pressure switch 34, relay 35, slip ring 37 and battery 41 are all electrically connected to the propeller reversing control switch 38 respectively through conductors 42, 43, 44, 45 and 46. The exact construction of switch 38 will be described in complete detail later.

In order to effect reversing of propeller 11 there must be an actuation of the propeller reversing control switch 38, and in the present invention, actuation of the switch 38 is accomplished through a suitable manually operated throttle control lever 47 which is provided with an arcuate cam surface 43 adapted to engage with and operate the switch 38. The throttle lever 47 is utilized for operation of the switch 38 since it is a control member conveniently located for easy reach by the operator. It is to be understood that the particular construction of throttle control lever 47 forms no part of this invention, as the invention contemplates the use of any usual engine throttle which can be associated with the propeller reversing control switch 38 in a manner to permit the manual force applied to the throttle to be transmitted to the switch 38 to actuate the latter.

Referring now to Figures 1 to 4 inclusive, the construction of the electrical instrumentality or propeller reversing control switch 38 is therein illustrated and as shown comprises a metallic casing or housing 51, formed with its ends and bottom open and having side walls 52 and 53 and a top wall 54. To effect a closed structure the ends are closed by suitable cover plates 55, only one of which is shown, and a base 56 of molded insulating material is fitted across the bottom opening. Suitable studs 57 threaded into the side walls 52 and 53 secure the cover plates 55 and base 56 in place.

Extending downwardly from the top wall 54 and inwardly, substantially centrally, from side wall 52 is a wall enlargement 58 having surfaces

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formed thereon against which generally L-shaped insulating members 61 can be disposed. Mounted within housing 51, one on each side of the wall projection 58, is a pair of similar unitary switch units 62 and 63. The switch units 62 and 63 are of the snap-acting type and include a pair of contacts 64 and 65 in spaced relationship and a movable contact member 66 operable between these contacts but normally being biased into engagement with one of the contacts such as 64. The particular construction of the switch units is not a part of this invention. For convenience these switch units 62 and 63 may be of the type described and claimed in Patent 2,237,705 to E. F. Kohl. For actuation in each switch unit of the snap-acting movable contact member 66 out of engagement with contact 64 and into circuit making engagement with opposed contact 65 there is provided an outwardly biased operating pin 67, which pin projects from the switch enclosing casing and is adapted to be depressed to provide the operating force for member 66.

To individually actuate the operating pins 67 of the switch units 62 and 63 there is located within the housing 51 and mounted between the units 62 and 63 an actuator arrangement 68, the construction of which is best shown in Figure 3. As there illustrated the actuator arrangement 68 comprises a pair of pivotal lever means 71 and 72. Lever means 71 comprises a pair of generally L-shaped arms 73 and 74, which arms are pivotally mounted at their upper ends by a pin 75 upon a depending portion or projection 76 provided by the top wall 54 of casing 51. At their free ends the arms 73 and 74 rotatably support a roller element 77. Projecting from arm 74 and integral therewith is an extension 78 which is bent to one side at substantially a right angle to arm 74. It is this projection 78 which is adapted to engage and depress pin 67 of switch unit 63 upon pivotal movement, in a clockwise direction, of lever means 71.

Lever means 72 also comprises a pair of generally L-shaped arms 81 and 82 which are mounted at one end for pivotal movement on wall portion 76 by the pin 75 and are disposed so that arm 81 lies outside of arm 73 and arm 82 lies outside of arm 74 of the lever means 71. The free ends of the arms 81 and 82 also rotatably support a roller element 83. Formed on arm 81 is a projection 84 which is bent over to extend to the outside of arm 81. Projection 84 is adapted to contact and move pin 67 of switch unit 62 for operation of this switch unit.

Disposed within housing 51 opposite from switch units 62 and 63 and adjacent side wall 53 is an electromagnet 85 comprising a core 86 with an energizing coil 87 disposed thereabout. A stud 88 passed through top wall 54 is adapted to be threaded into core 86 to secure the electromagnet 85 against the interior surface of top wall 54. A lock washer and nut assembly 91 carried on stud 88 positions and maintains the stud in a desired position as will be discussed in further detail hereinafter.

Associated with electromagnet 85 is a movable contact carriage assembly 92 having an armature member 93 extending beneath the electromagnet 85 for cooperation therewith. Movable contact carriage assembly 92 comprises a bracket member 94 having a plate-like portion 95 to the upper surface of which the armature 93 is secured by studs, or in any other well known manner. The bracket member 94 includes a pair of upstanding arms 96 and 97 through which the bracket

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member 94 is pivotally mounted by a pivot pin 98 upon a wall portion 101 depending from the top wall 54. Upwardly bent from the portion 25 are a pair of lugs or ears 102 which are provided to support rotatably a roller element 103. To the under face of bracket member 94 is suitably fastened a pair of rectangular insulating blocks 104 and 105, with insulating block 104 disposed intermediate bracket 94 and block 105. Supported in horizontal alignment by the insulating blocks 104 and 105 are a plurality of generally L-shaped conducting pieces 106, 107 and 108, each having one leg 109 disposed and tightly pressed between the insulating blocks 104 and 105, and having a free leg 111 extending downwardly from the support afforded by the blocks 104 and 105, with appropriate contact faces 112 being carried by these free legs 111. As shown in the drawings the ends of legs 109 of conducting pieces 106, 107 and 108 extend beyond their engagement by blocks 104 and 105 to provide attachment points for electrical leads. The depending legs 111 of the conducting pieces 106, 107 and 108 are adapted to engage and disengage a plurality of contact members mounted on and extending from insulating base 56 for making and breaking electric circuits therethrough. As indicated on the wiring diagram of Figure 10 conducting piece 106 cooperates with a stationary contact member 113, central conducting piece 107 is engageable with a pair of stationary contacts 114 and 115, and conducting piece 108 makes and breaks a circuit through stationary contact member 116. The various stationary contacts 113, 114, 115, and 116 comprise flexible upstanding portions 117 to permit a slight sliding engagement with contact faces 112 for the purpose, as is well known in the art, of lessening any tendency to burn or pit of the contacts.

A resistor member 118 is mounted through a bracket 121 on side wall 53 of housing 51 and serves to limit the amount of current passed to the energizing coil 87 of the electromagnet 85.

Located adjacent and above resistor 118 is a stop member 122 formed by an integral portion bent outwardly from bracket 121. Stop member 122 is adapted to be engaged by the armature member 93 to determine the extent of movement of this member away from the electromagnet 85. A usual wire spring means 123 having a portion thereof wound around pivot pin 98 and with one end bearing upon bracket member 94 and the other end positioned against the inner surface of top wall 54 biases the contact carriage assembly 92 for movement in a clock-wise direction, as viewed in Figures 1 and 2, to move the armature member 93 against stop 121 and normally to maintain the depending legs 111 of pieces 106, 107 and 108 disengaged from their respective cooperating stationary contacts.

There is included in control switch 38 a mechanism for moving pivotally the contact carriage assembly 93 and the two lever means 71 and 72 of actuator arrangement 68. This mechanism includes a reciprocal elongated plunger 124 extending through the top wall 54 of housing 51 and into the housing 51 to lie disposed between the actuator arrangement 68 and the contact carriage assembly 93. Carried by the top wall 54 is a suitable bushing member 125 which functions as a close-fitting guide for plunger 124. Near the outer end of the plunger 124 is rigidly affixed a generally cup-shaped washer member 126. A spring 127 encircling the outwardly disposed portion of plunger 124 and having one end

seated against washer 126 and the other against the housing 51 exerts its bias to urge the plunger 124 outwardly from casing 51.

The portion of plunger 124 disposed within casing 51 and extending below the lower end of bushing member 125 is provided with a generally V-shaped circumferential camming ridge 128, a large diameter portion 131 which is connected through a slope to a small diameter portion 132, which latter portion in turn is connected by a sloping portion to a projecting portion 133, extending directly downwardly from small diameter portion 132. Camming ridge 128 being of larger diameter than the lower end of bushing 125 prevents the removal of the plunger 124 through the top wall 54.

For reciprocal operation of the plunger 124 an actuating arm 134 is provided which is pivotally mounted at one end 135 to a generally U-shaped mounting bracket member 136 suitably secured as by stud means 137 to the top wall 54. The free end 138 of arm 134 carries a generally U-shaped bracket 141 which rotatably supports a roller 142. Roller 142 is adapted to be engaged by cam surface 43 of throttle control lever 47 to effect pivotal movement, in a counter-clockwise direction, of the arm 134 toward the housing 51. To the undersurface of arm 134 is secured one end of a leaf spring element 143. The free end of spring element 143 bears against a projection 144 provided at the outer end of plunger 124. Spring element 143 functions as an over-travel device in the transmittal of motion from arm 134 to plunger 124. To adjust the position of the free end of arm 134 use is made of the stud 88 which mounts the electromagnet 85 within casing 51. Stud 88 is adapted to project through a key-hole slot 145 in arm 134 so that its head 146 may engage the upper surface arm 134 and apply a holding force thereagainst. Stud 88 will permit the roller 142 to be adjusted to the best position for cooperation with cam surface 43 on throttle control lever 47.

Reference will now be had to the wiring diagram of Figure 10. This figure illustrates the incorporation of the reversing control system 25 with the feathering control system for the propeller 11. Combining the two systems permits the utilization by both control systems of certain of the same devices, such as the solenoid valve 33, pressure switch 34, relay 35, the electric motor driven pump 26, and the propeller blade slip ring 37.

Further provided to complete the feathering control system are a push-pull electric switch 146 and a double-pole relay 147. Push-pull electric switch 146 embodies four pairs of opposed contact members, 148a and 148b, 149a and 149b, 150a and 150b, and 151a and 151b. A bridging movable contact 142 is disposed between the pairs of contact members for circuit-making cooperation with such contacts in groups of four comprised of one contact from each pair.

The push-pull switch 146 also includes a manually operated actuator 153 and a hold-in coil 154. Actuator 153 is adapted to move bridging contact 152 in either direction from its normally-contacts disengaged position into circuit-making engagement with the various contact sets of switch 146. The hold-in coil 154 functions to maintain actuator 153 in its depressed or "in" position. Hold-in coil 154 is electrically connected at one end to contact 150b and is connected at its other end by electrical lead 155 to ground through pressure switch 34.

The double-pole relay 147 embodies a pair of switch arms 156 and 157 and an energizing coil 158 operatively connected to the switch arms 156 and 157 for movement thereof from their normally open positions into circuit making positions. The double pole relay 147 and the push-pull switch 146 are electrically interconnected with switch arm 156 being connected through leads 159 to contacts 149a and 149b, switch arm 157 being connected by lead 161 to contact 150a, and coil 158 being connected at one end to contact 151a through lead 162. The other end of coil 158 is joined by lead 163 to blade brush 164. Blade brush 164 is adapted to cooperate with contact segments 165 and 166 when propeller blade 13 rotates to complete a circuit to ground for purposes to be described.

Switch arm 156 on energization of coil 158 engages contact 167 of relay 147 which is connected by appropriate electrical leads 168 to pump relay 35. It is noted that one of these leads 168 extends between contact 151b of push-pull switch 146 and pump relay 35, connecting to energizing coil 169 of the relay.

Switch arm 157 on energization of coil 158 moves into engagement with stationary contact 171 which connects through lead 172 to solenoid valve 33.

Direct current power to the push-pull switch 146 is provided through lead 173 which connects to both contacts 148a and 148b. This power may be taken from any primary current supply source, and, conveniently could be led from battery 41.

The electric connections from propeller reversing control switch 33 to the various devices required to effect reversing of the propeller 11 will now be discussed.

Lead 42 interconnects the solenoid valve 33 with movable contact arm 66 of switch unit 63. Contact 64 of switch unit 63 is connected by conductor 174 to contact 116 which cooperates with conducting piece 103 of movable contact carriage 92. Stationary contact 65 of switch unit 63 is connected by lead 46 to battery 41 which in turn is connected through an appropriate lead 175 to contact 176 of relay 35. Contact 176 is adapted to be engaged by movable contact 177 on energization of coil 169 to complete a circuit through lead 36 to pump motor 27. Stationary contact 65 of switch 63 is adapted to be connected also to normally engaged stationary contact 64 of switch unit 62 by a lead 178. Oppositely disposed contact 65 connects through lead 181 to switch unit 63 and thence through lead 42 to solenoid valve 33.

Pressure switch 34 is connected to one end of energizing coil 87 of electromagnet 85 by lead 43. This same end of coil 87 is then connected by flexible lead 182 to conducting piece 108. The opposite end of coil 87 is connected by flexible lead 183 to conducting piece 107. A flexible lead 184 connects conducting piece 106 to switch unit 62. Stationary contact 113 which is engageable by movable conducting piece 106 is connected by lead 44 to energizing coil 169 of relay 35. Stationary contact 114 engageable by conducting piece 107 connects through lead 180 to resistor 119 which latter is connected to power supply lead 46 by a lead 185. Stationary contact 115 is also engageable by conducting piece 107 to complete a circuit through appropriate leads 163 and 186 to blade brush 164 of the slip ring assembly 37.

It is understood that push-pull switch 146 and

double-pole relay 147 do not enter into the control of the reversing and unreversing movements of the propeller 11. They are included merely to complete the feathering control system to illustrate that feathering control of propeller 11 and reversing control of propeller 11 involves common use of a substantial number of control elements to avoid duplication of parts.

Since the feathering of propeller 11 is incidental to the present invention this operation will be described only briefly. To effect feathering of propeller 11 the actuator button 153 is depressed. This will energize coil 169 of relay 35 to close the circuit to motor 27 to start operation of pump 26. Hold in coil 154 is also energized by current flowing therethrough to ground through pressure switch 34. Pump 26 continues to supply fluid to governor 21 to cause it to provide pressure to the outboard side of piston 16 to rotate propeller blade segments 13 toward high pitch and feather position. As soon as the position is reached mechanical stops, not shown, in well known manner halt the blades and cause the pressure in the governor to build up to a predetermined value, at which the pressure switch 34 is adapted to cut out and break the circuit therethrough. This results in de-energization of hold-in coil 154 and actuator 153 returns to its neutral position whereby the pump 26 stops and the feathering operation is completed.

To unfeather propeller 11 the actuator 153 is manually moved in the reverse direction to cause movable contact 152 to bridge contacts 148a, 149a, 150a and 151a. With the bridging of these contacts coil 158 of relay 147 is energized by completion of a ground through brush 164 resting on contact segment 166. Arms 156 and 157 move to circuit making position to energize solenoid valve 33 and relay 35. Fluid will then flow from pump 26 through governor 21 to the inboard side of piston 16 to rotate propeller blade segments 13 to assume a low pitch angle. When a predetermined blade angle is attained an insulated portion on slip ring 37 is presented to brush 164 to break the circuit to relay 147, deenergizing it and inactivating pump 26.

Propeller reversing and unreversing operations will now be described. Assuming the propeller 11 to be functioning in normal, or low pitch, condition the propeller reversing control switch 38 will have its operating parts disposed in the positions illustrated in Figures 1, 2 and 9. As seen pivoted arm 134 will be in its upper position, as will plunger 124. Roller 103 carried by contact carriage assembly 92 will lie adjacent large diameter portion 131 of plunger 124 and beneath camming ridge 128. Roller 77 of lever 71 will be disposed contiguous small diameter plunger portion 132, while roller 83 of associated lever 72 abuts plunger projection 133.

When it is desired to reverse propeller 11 the throttle control lever 47 is operated to move cam surface 48 upon roller 142 carried by pivoted arm 134 to rotate arm 134 toward the top of casing 51 of reversing control switch 38. This movement of arm 134 applies a force to the upper end of plunger 124 to move it longitudinally, against the bias of spring 127, into casing 51. As plunger 124 moves rectilinearly toward base 56 the lowermost roller 83 will ride from projection 133 onto small diameter portion 132 to actuate switch unit 62, camming ridge 128 will engage uppermost roller 103 to position armature 93 adjacent coil 87 and intermediate roller 77 will ride upon large diameter portion 131

before camming ridge 128 passes beneath upper roller 103.

Reference should now be had to Figure 10 to describe the results of the actuation of plunger 124. Riding up of lowermost roller 83 onto small diameter plunger portion 132 will pivot lever 72 to cause projection 84 thereon to depress actuating pin 67 of switch unit 62. This will cause movable contact 66 to move from contact 64 into engagement with opposed stationary contact 65. Engagement of uppermost roller 103 by plunger camming ridge 128 rotates contact carriage assembly 92 to position, as stated, armature 93 adjacent coil 87 and, further, to bring conducting piece 106 into engagement with stationary contact 113, conducting piece 107 into engagement with stationary contacts 114 and 115 and conducting piece 108 into engagement with stationary contact 116. With contact 114 engaged by conducting piece 107 current can be supplied through resistor 118 to energize coil 87 of electromagnet 85 to hold armature 93 in closed position and thereby maintain contact carriage assembly 92 in actuated position. Intermediate roller 77 riding onto large diameter plunger portion 131 pivots lever 71 to cause projection 78 thereof to depress actuating pin 67 of switch unit 63. This causes movable contact arm 66 to engage stationary contact 65 of switch unit 63 to complete the circuit to solenoid valve 33. Furthermore current can now flow from movable contact arm 66 of switch unit 63 through lead 181 to movable contact arm 66 of switch unit 62, from which it passes by way of lead 184 through engaged contacts 106-113 to lead 44 and then to coil 169 of relay 35. Relay 35 now functions to energize motor 27 to run pump 26 to begin the operation of reversing propeller 11. At this point the relative positions of the elements of reversing control switch 38 are as illustrated in Figure 6. Pump 26 directs a flow of oil through the governor 21 and through line 22 to the cylinder 17 at the rear of piston 16 to effect rotation of the propeller blade segments 13 into reverse angle position. At the end of the reversing operation pressure builds up to a predetermined value to actuate pressure switch 34 to break the circuit through electromagnet coil 87 to release armature 93 thereby permitting contact carriage assembly 92 to rotate under the bias of spring 123 into its neutral position. This causes conducting piece 106 to separate from stationary contact 113 to break the circuit to relay 35 to inactivate pump 26. Solenoid valve 33 remains energized through switch 63 and serves to hold the propeller 11 in its reversed position. Figure 7 is illustrative of the relative positions of the elements of reversing control switch 38 when propeller is reversed.

To unreverse propeller 11 and return it to normal position the throttle control lever is operated to disengage camming surface 48 from roller 48 on arm 134. This permits plunger 124 to move upwardly under the bias of its spring 127. In this movement of plunger 124 intermediate roller 77 will ride off of large diameter plunger portion 131 permitting lever 71 to be rotated away from switch unit 63 under pressure of the outwardly biased pin 67 of switch unit 63. Contact arm 66 thereupon disengages contact 65 and returns to its normally engaged position on stationary contact 64. This results in the breaking of the circuit to solenoid valve 33. Cam 128 engages uppermost roller 103 to

rotate contact carriage assembly 92 to effect engagement between the conducting pieces 106, 107 and 108 and their cooperating contacts 113, 114, 115 and 116. Power will then be supplied to energizing electromagnetic coil 87 through resistor 118 and contacts 114 and 107 to cause coil 87 to hold armature 93 adjacent thereto and thereby maintain contact carriage assembly 92 in rotated position. Normally ground for the coil 87 is provided through lead 44 and pressure switch 34. However in the event that pressure switch 34 fails to be in closed position either because of a pressure surge in the flow lines or because the throttle was moved so fast that it did not have sufficient time to close a secondary ground is provided. This secondary ground is had through lead 182, engaged contact elements 108 and 116, lead 174, movable contact arm 66 of switch unit 63, lead 42 and then through solenoid valve 33. This insures that a circuit is provided for the coil 87 for maintaining the contact carriage assembly in operated position.

Further upward movement of plunger 124 now permits lowermost roller 83 to travel from small diameter plunger portion 132. This relieves the pressure on pin 67 of switch unit 62 permitting the pin 67 to move outwardly and rotate lever 72. Movable contact arm 66 now disengages contact 65 and re-engages stationary contact 64 to complete a circuit from battery 41 through engaged conducting piece 106 and contact 113 to lead 44 and to coil 169 of relay 35. Relay 35 now energizes motor 27 and starts pump 25. This stage the positions of the elements of reversing switch 38 are as illustrated in Figure 8. Oil pressure will now be routed by the governor 21 through line 23 to cylinder 17 to the outboard side of piston 16. Piston 16 moves to rotate propeller blade segments 13 into positive normal thrust angle. When the propeller segments 13 reach positive pitch contact 165 of the slip ring assembly 37 engages brush 164. This results in shorting out of electromagnetic coil 87 through contact 115, conducting piece 107, lead 186 and lead 163. De-energization of coil 87 releases armature 93 and permits contact carriage 92 to return under spring bias to its normal position, as shown in Figure 9, to disengage conducting piece 106 and contact 113 to interrupt the circuit to relay 35 and stop pump 26 and thus return the system to its normal condition.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims:

I claim:

1. An electric circuit controlling instrumentality comprising a pair of electric switches, a first movable means for operating one of said electric switches, a second movable means for operating the other of said electric switches, an electro-magnet, an armature normally spaced from said electro-magnet and movable toward and away from said electro-magnet, a movable contact, a stationary contact, a switching member mounting said movable contact normally spaced from said stationary contact, said switching member being operatively connected to said armature and movable therewith to perform a switching operation, and actuating means movable to actuate said first and second movable means to operate said pair of electric switches, said actuating

means, in the same movement, moving said switching member to engage said movable contact with said stationary contact, and moving said armature into position to be held magnetically by the electro-magnet.

2. In an electric circuit controlling instrumentality comprising a housing, a pair of electric switch means supported in said housing, a first pivoted lever means for operating one of said electric switch means, a second pivoted lever means for operating the other of said electric switch means, an electro-magnet mounted in said housing, a movable armature normally spaced from said electro-magnet, a movable contact, a stationary contact, a switching member mounting said movable contact normally spaced from said stationary contact, a movable supporting member mounting said armature and said switching member for common movement, and a reciprocable actuating plunger movable to actuate said first and second lever means to operate said pair of electric switches, said plunger, in this same movement, actuating said supporting member to move said switching member to engage said movable contact with said stationary contact and simultaneously move said armature into position to be held magnetically by the electro-magnet.

3. In an electric circuit controlling instrumentality comprising a housing, a pair of electric switch means supported in said housing, a first pivotally mounted lever means for operating one of said electric switch means, a second pivotally mounted lever means for operating the other of said electric switch means, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a movable armature normally spaced from said electro-magnet, a movable contact, a stationary contact, a switching member mounting said movable contact spaced from said stationary contact, a pivoted supporting member mounting said armature and said switching member for common movement, and an axially movable actuating plunger, slidably supported by said housing, movable to actuate said first and second pivotally mounted lever means to operate said pair of electric switches, said actuating means, in this same movement, actuating said pivoted member to move said switching member to engage said movable contact with said stationary contact and at the same time to move said armature into position to be held magnetically by the electro-magnet.

4. In an electric circuit controlling instrumentality comprising a housing, an actuating plunger slidably supported by said housing for endwise movement, a pair of electric switch means supported in said housing, pivotally mounted means for operating said pair of electric switch means, with the pivot axis of said means being disposed at one side of the plunger, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a movable armature normally spaced from said electro-magnet, a switching member, a pivoted supporting means mounting said armature and said switching member for common movement, with the pivot axis of said pivoted supporting means being disposed on the opposite side of said plunger from said first mentioned pivot axis, means for moving said actuator plunger to actuate said first and second pivotally mounted lever means to operate said pair of electric switches, said actuating plunger, in this same movement, actuating said pivoted supporting means to move said switching mem-

ber to perform a switching operation and at the same time to move said armature into position to be held magnetically by the electro-magnet.

5. In an electric circuit controlling instrumentality comprising a housing, a pair of electric switch means supported in said housing, a first pivotally mounted lever means for operating one of said electric switch means, a second pivotally mounted lever means for operating the other of said electric switch means, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a pivotally mounted armature normally spaced from said electro-magnet, a switching member operatively connected to said armature for movement therewith between circuit-making and circuit-breaking positions, an actuating plunger movably supported on said housing for endwise movement, a first portion on said actuating plunger for engaging said pivotally mounted armature, on movement of said plunger, to move said armature into position closely adjacent said electro-magnet to be held magnetically thereby on energization of the electro-magnet, a second portion on said actuating plunger for engaging the first pivotally mounted lever for movement thereof to operate its associated electric switch, and a third portion on said actuating plunger for engaging the second pivotally mounted lever means for moving it to operate its associated electric switch, said switching member moving, on movement of said armature, into circuit-making position.

6. In an electric circuit controlling instrumentality comprising a housing, a reciprocable actuating plunger, a pair of electric switch means supported in said housing, a first pivotally mounted lever means for operating one of said electric switch means, with the pivot axis of said lever means disposed on one side of said plunger, a second pivotally mounted lever means for operating the other of said electric switch means, with the pivot axis of this latter lever means mounted on the same side of said plunger as is the pivot axis of the first lever means, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a movable armature normally spaced from said electro-magnet, pivoted supporting means carrying said armature, the pivot axis of said supporting means being disposed on the opposite side of said plunger from said first mentioned pivot axis, a switching member operatively connected to said armature for common movement therewith between circuit-making and circuit-breaking positions, a camming portion on said actuating plunger for engaging said pivoted armature supporting means, on movement of said plunger, to move said armature into position adjacent said electro-magnet to be held magnetically thereby on energization of the electro-magnet, a large diameter portion on said actuating plunger for engaging the first pivotally mounted lever means for movement thereof to operate its associated electric switch, and a small diameter portion on said actuating plunger for engaging said second pivotally mounted lever means for moving it to operate its associated electric switch, said switching member moving, on movement of said armature, into circuit-making position.

7. In an electric circuit controlling instrumentality comprising a housing, a longitudinally movable actuating plunger slidably mounted on said housing having an end movable within the interior of said housing, a pair of electric switch means supported in said housing, a first pivotally

mounted lever means for operating one of said electric switch means, a roller rotatably supported by said lever means, a second pivotally mounted lever means for operating the other of said electric switch means, a roller rotatably supported by this second lever means, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a movable armature normally spaced from said electro-magnet, a switching member, a pivoted supporting means mounting said armature and said switching member for common movement, a roller mounted for rotation on said pivoted supporting means, a camming portion on said actuating plunger coacting with the roller on said pivoted armature supporting means to move said switching member into circuit-making position and to move said armature into position immediately adjacent said electro-magnet to be held magnetically thereby on energization of the electro-magnet, a large diameter portion coacting with the roller on the first pivotally mounted lever means for movement thereof to operate its associated electric switch, and a small diameter portion on said actuating plunger for engaging said second pivotally mounted lever means for moving it to operate its associated electric switch.

8. In an electric circuit controlling instrumentality comprising a housing, an actuating plunger slidably supported by said housing for endwise movement therein and comprising a cam portion, a large diameter portion, a small diameter portion and a projecting portion extending from the end of the small diameter portion, a pair of electric switch means supported in said housing, a first pivotally mounted lever means for operating one of said electric switch means, with the pivot axis of said lever means disposed on one side of said plunger, a roller rotatably supported by said lever means and abutting said small diameter portion, a second pivotally mounted lever means for operating the other of said electric switch means, with the pivot axis of said second lever means mounted on the same side of said plunger as is the pivot axis of the first lever means, a roller rotatably supported by said second lever means contiguous to said projecting portion on said plunger, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a movable armature normally spaced from said electro-magnet, a switching member, a pivoted supporting member mounting said armature and said switching member for common movement, the pivot axis of said supporting means being disposed on the opposite side of said plunger from said first mentioned pivot axes, a roller mounted for rotation on said pivoted supporting member and abutting said large diameter portion, and means for moving said actuating plunger in a first direction to move said roller carried by said second lever means, into engagement with said small diameter portion thereby to move said second lever means to operate its associated electric switch, said movement of said actuating plunger causing said camming portion to coact with the roller on the pivoted armature supporting member to move the switching means to perform a switching operation and to move the armature into position immediately adjacent said electro-magnet to be held magnetically thereby on energization of the electro-magnet, this movement of actuating plunger in a first direction also causing the large diameter portion of the plunger to coact with the roller on the first piv-

otally mounted lever means to move said first lever means to operate its associated electric switch.

9. In an electric circuit controlling instrumentality comprising a housing, a longitudinally movable actuating plunger slidably mounted on said housing having an end movable within the interior of said housing, a pair of electric switch means supported in said housing, a first pivotally mounted lever means mounted adjacent said plunger, for operating one of said electric switch means, a roller rotatably supported by said lever means to be positioned abutting said plunger spaced from the interior end thereof, a second pivotally mounted lever means mounted adjacent said plunger and on the same side thereof as the first lever means for operating the other of said electric switch means, a roller rotatably supported by this second lever means and abutting on said plunger closer to the end thereof than said roller on said first lever means, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a movable armature normally spaced from said electro-magnet, a switching member, a pivoted supporting means, positioned adjacent said plunger on the opposite side thereof than said first and second lever means, mounting said armature and said switching member for common movement, a roller mounted for rotation on said pivoted supporting means and in abutment on said plunger farther from the end thereof than the other two rollers, a camming portion on said actuating plunger coacting with the roller on said pivoted armature supporting means to move said switching member into circuit-making position and to move said armature into position immediately adjacent said electro-magnet to be held magnetically thereby on energization of the electro-magnet, a large diameter portion coacting with the roller on the first pivotally mounted lever means for movement thereof to operate its associated electric switch, and a small diameter portion on said actuating plunger for engaging said second pivotally mounted lever means for moving it to operate its associated electric switch.

10. In an electric circuit controlling instrumentality comprising a housing, a pair of electric switch means supported in said housing, a first pivotally mounted lever means for operating one of said electric switch means, a second pivotally mounted lever means for operating the other of said electric switch means, an electro-magnet mounted in said housing spaced from said pair of electric switch means, a movable armature normally spaced from said electro-magnet, a switching member, a pivoted supporting member mounting said armature and said switching member for common movement, an actuating plunger slidably supported by said housing, spring means operatively connected to said actu-

ating plunger for urging said plunger in a first direction, and movable means mounted upon the exterior of said housing for engaging and moving said actuating plunger in the opposite direction and against the action of said spring means to actuate said first and second pivotally mounted lever means to operate said pair of electric switches, said actuating plunger in this same movement, actuating said pivoted supporting member to move said switching member to perform a switching operation and simultaneously moving said armature closely adjacent said electro-magnet in position to be held magnetically by the electro-magnet.

11. In an electric circuit controlling instrumentality comprising a housing, a pair of electric switch means supported in said housing, a first lever means for operating one of said electric switch means, a second lever means for operating the other of said electric switch means, an electro-magnet mounted in said housing, a movable armature normally spaced from said electro-magnet, a switching member, a movable supporting member mounting said armature and said switching member for common movement, and a reciprocable elongated actuating plunger slidably supported by said housing and extending from the exterior thereof into operative position within said housing, spring means operatively connected to said plunger for urging it for movement outwardly of said housing, and a pivotal member mounted upon the exterior of said housing for engaging the exteriorly disposed end of the plunger to move said plunger inwardly and against the action of said spring means to actuate said first and second lever means to operate said pair of electric switches, said plunger in this same movement, actuating said supporting member to move said switching member to perform a switching operation and simultaneously move said armature closely adjacent said electro-magnet in position to be held magnetically by the electro-magnet.

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