June 23, 1953 E. MARTIN ET AL 2,643,077

PROPELLER CONTROL MECHANISM

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Fig. 4.

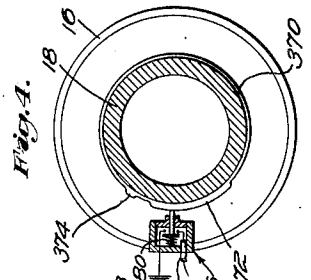


Fig. 3.

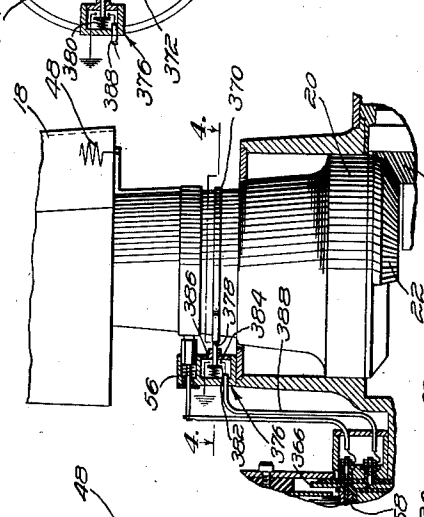


Fig. 1.

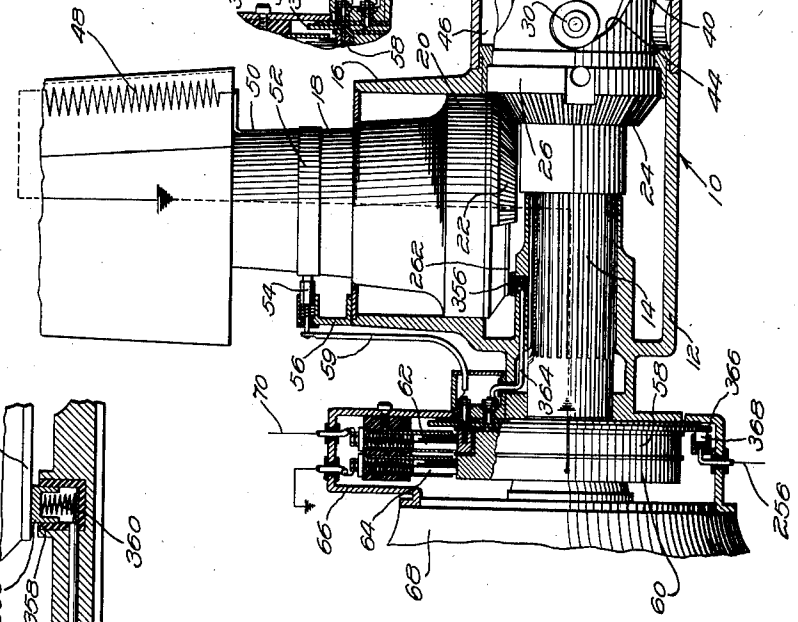
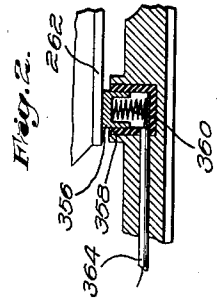


Fig. 2.



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PROPELLER CONTROL MECHANISM

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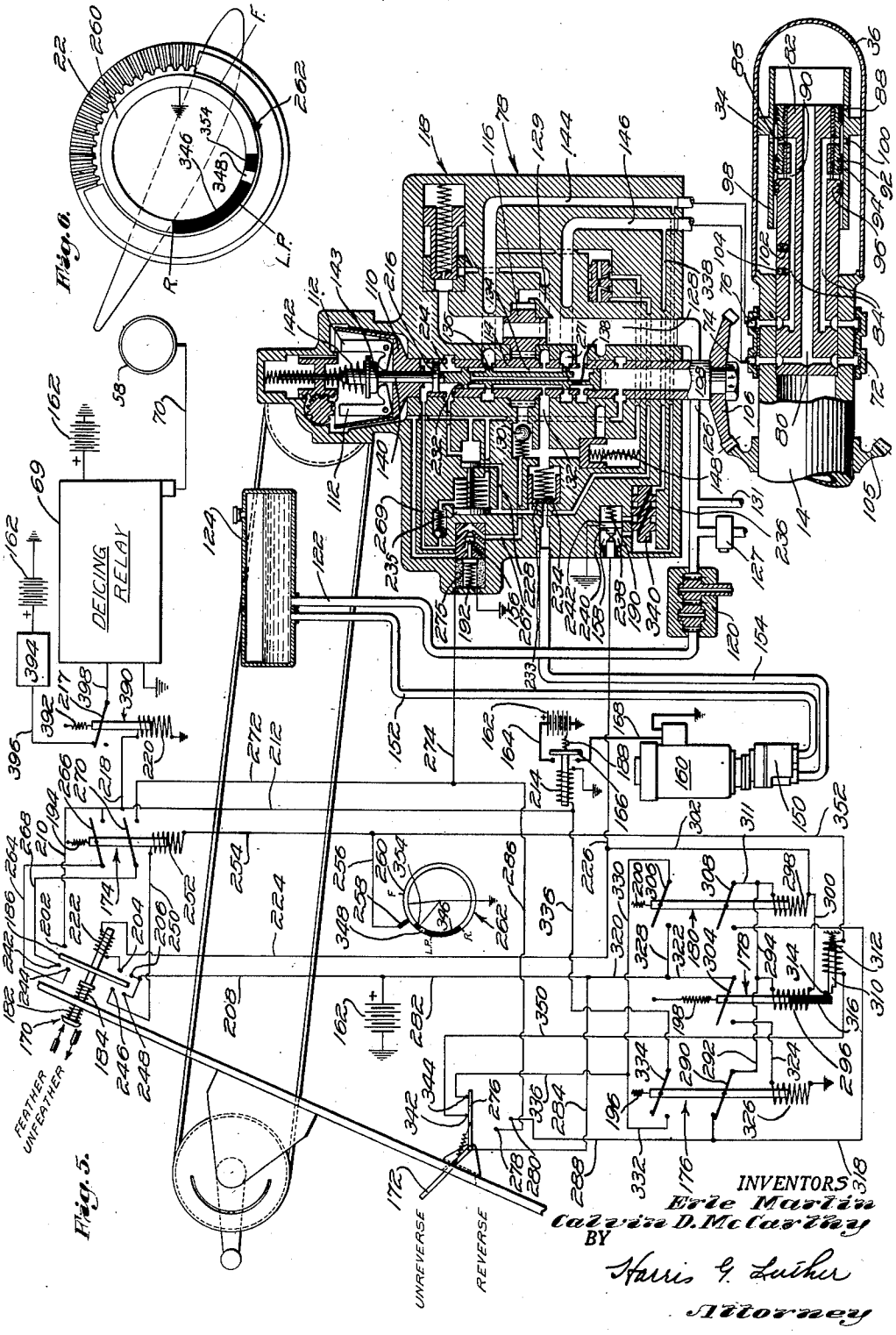


Fig. 6.

Fig. 5.

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PROPELLER CONTROL MECHANISM

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Fig. 7.

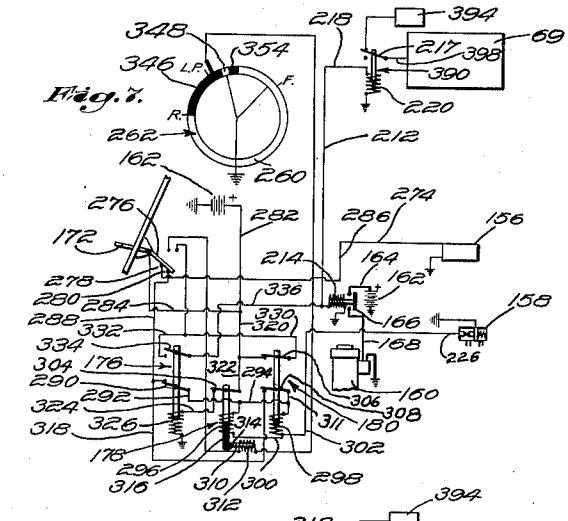


Fig. 8.

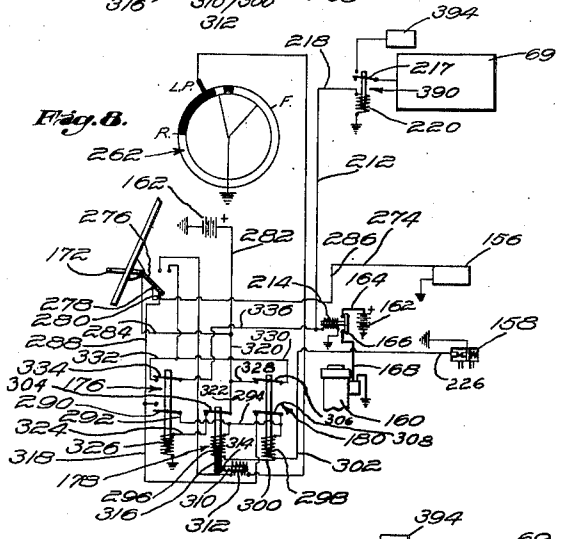
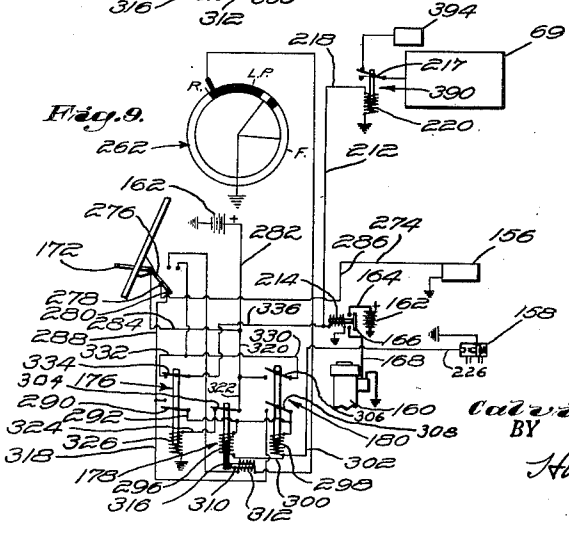


Fig. 9.



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UNITED STATES PATENT OFFICE

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PROPELLER CONTROL MECHANISM

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Application June 10, 1948, Serial No. 32,244

15 Claims. (Cl. 244—134)

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This invention relates to hydraulically controllable propellers and particularly to propellers of this type which may be feathered or reversed and to improved control mechanism operative during unfeathering and unreversing of the propeller blades.

In propellers having pitch changing means capable of turning the blade beyond the normal operative range, in which the pitch angle is usually automatically controlled by governor into extreme or special purpose ranges such as feathered or reverse pitch positions, it is usual to operate the propeller blades in the normal range by a relatively low fluid pressure which is adequate to overcome the aerodynamic and centrifugal twisting moments exerted against these blades in this range. The blades are usually moved into and out of the extreme positions thereof by a higher fluid pressure to which the propeller pitch changing mechanism is subjected only while the propeller is in or being changed to or from these extreme special purpose ranges.

It is an object of this invention to provide improved means for controlling admission of the higher pressure fluid (hereinafter referred to as the high pressure fluid) to the propeller.

Another object of the invention is to provide improved means operative during unfeathering and unreversing for automatically interrupting the source of high pressure fluid to the propeller pitch changing mechanism when the propeller has returned to the governor controlled constant speed and range.

A further object of the invention is to provide means for interrupting the propeller electrical deicing system while the propeller pitch changing mechanism is being changed to or from the extreme special purpose positions of feather or reverse pitch.

A still further object of the invention is generally to improve the construction and operation of governor controlled pitch changing propellers.

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

In the drawings;

Fig. 1 is a diagrammatic longitudinal section through a propeller hub constructed according to the invention.

Fig. 2 is an enlarged showing of a portion of Fig. 1 illustrating the brush and slip ring at the blade end.

Fig. 3 is a longitudinal section through a propeller hub similar to Fig. 1 showing an alternate construction of the invention.

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Fig. 4, section 4—4 of Fig 3.

Fig. 5 is a diagrammatic view showing the propeller hub, the constant speed control means and associated control apparatus for feathering, unfeathering, reversing and unreversing the propeller with the parts shown in the position assumed during constant speed operation, on speed condition, the constant speed control means and the propeller hub being shown in section.

Fig. 6 is a view of the shank end of the propeller blade showing the position of the control slip ring with respect to the blade.

Fig. 7 is a diagrammatic view showing the portion of control apparatus of Fig. 5 used during reversing with the parts shown in the first position assumed as reversing switch is operated.

Fig. 8 is Fig. 7 showing the parts in the position immediately following the action shown in Fig. 7.

Fig. 9 is Fig. 7 showing the parts in the position assumed upon the completion of reversing with the propeller in the reverse pitch position.

Fig. 1 diagrammatically illustrates the principal elements of the improved controllable pitch feathering and reversing type propeller. Such a propeller as generally indicated at 10 normally comprises a hub portion 12 mounted by longitudinal splines on propeller 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 the longitudinal axis in pitch changing directions and may be retained in the sockets by suitable antifriction bearings, not illustrated, interposed between a socket abutment and a flange 20 on the blade end in a 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 22 for blade 18, all of which gear sectors mesh with a master gear 24 supported by the hub 12 and rotatable about the longitudinal axis of the hub. Gear 24 is mounted on a rotatable member 26 rotated through a cam and follower mechanism, including movable cam 28, cam rollers 30 and fixed cam 32, by a piston 34 reciprocable in a cylinder 36 connected to the front end of hub 12 and having fluid connections to the opposite ends thereof as will be described later. The movable cam slots, as generally indicated at 38, have a substantially straight intermediate portion 40 for constant speed control, a steep pitch portion 42

at the high pitch end for feathering the propeller, and a steep pitch portion 44 at the low pitch end for reversing the propeller. The cam slots 46 of the stationary cam 32 are similarly designed but slope in the opposite direction.

The propeller may be provided with an electrical deicing system for preventing the formation of ice or removing ice from the blades which may accumulate during operations under icing conditions. The deicing system generally consists of a blade heating element 48 mounted on the leading edge of the blade 18, a deicing relay 69 and a deicing timer 394 (Fig. 5). The heating element 48 is connected by conductor 50 to a blade deicing slip ring 52. A brush 54 carried by suitable insulating means in a housing and bracket 56 which is mounted on hub blade receiving socket 16, forms a sliding contact with blade deicing slip ring 52 and is connected with propeller deicing slip ring 58 by conductor 59. Propeller deicing slip rings 58 and 60 are secured to the propeller hub 12 for rotation therewith. Slip ring 60 forms the ground connection for propeller deicing as well as for the contact slip ring 262, the latter will be described later. Brushes 62 and 64 are mounted by suitable insulation in brush housing 66 and form wiping contact with slip rings 58 and 60, respectively. Brush housing 66 is nonrotatably secured to the engine 68. Brush 64 is connected to the ground at a suitable place in the airplane and brush 62 is connected to the deicing relay 69 (see Fig. 5) by conductor 70. Electrical energy for operating the blade heating elements in supplied to the deicing relay 69 from a suitable source, such as a battery 162. A deicing timer 394, supplied with electrical energy from battery 162, for actuating the deicing relay 69 and is connected thereto by conductor 396, switch 217 of relay switch of 390 and conductor 298. A control slip ring, generally indicated at 262, is provided on the butt end of the blade 18 inside propeller hub 12. This control slip ring 262 (Fig. 6) is provided with two insulated segments 346 and 354. The remainder of the slip ring, segments 348 and 260, is electrically conducting to the propeller blade. Insulating segment 346 corresponds to the reverse pitch range of the propeller blade plus a few degrees in the low pitch range. Insulating segment 354 is near the high pitch end of the constant speed range. A brush 356 is carried by an insulating housing 358 which is secured in the propeller hub 12 and is held in contact with slip ring 262 by a compression spring 360. Conductor 364 connects brush 356 through spring 360 with slip ring 366 which is rotatably secured with proper insulation to propeller hub 12. A brush 368 which forms a wiping contact with slip ring 366 is mounted in suitable insulation and carried by nonrotatable housing 66. Conductor 256 which returns from brush 368 connects with the unreversing and unfeathering circuit as shown in Figs. 5, 7, 8 and 9.

An alternate method of construction that may be used in lieu of the previously described contact slip ring is shown in Figs. 3 and 4. It consists of a cam 370, secured to blade 18, having two raised segments 372 and 374 which correspond to insulating segments 346 and 354 respectively of contact slip ring 262. Cam 370 has the same position relative to the blade chord center line as has slip ring 262. Switch 376, mounted on bracket 56, consists of a plunger or cam follower 378 and is held in contact with cam 370 by compression spring 380. A bridging contact 382 is secured to plunger 378. When plunger 378 is in contact with the raised segments 372 or 374 bridging member 382 is out of contact with contacts 384 and 386. When plunger 378 is between the raised cam segments or riding in the cam depressions, bridging member 382 will form a circuit with conductor 256, brush 368, slip ring 366, conductor 388, contact 384, bridging member 382, contact 386 which returns to ground in the propeller.

Still another method of providing a control means for stopping unfeathering and unreversing can be accomplished by forming blade deicing slip ring 52 (Fig. 1) with an insulated portion identical in length of arc and position to segment 346 of control slip ring 262. It will be connected to the unfeathering and unreversing electrical circuit conductor 256 through slip ring 58, brush 62 and conductor 70 and control slip ring 262 and its associated mechanism will be omitted.

A shaft 14 is rotatable in an oil sealed bearing 72 (Fig. 5) having two external fluid connections 74 and 76 leading from the governor mechanism generally indicated at 78. The connection 74 leads through radial ports to a channel 80 extending outboard through a member 82 which is an extension of shaft 14. An annular piston 34 in cylinder 36 has a tubular hub extension 98 mounted for reciprocation on shaft extension 82. Connection 76 leads through radial ports and longitudinal channels 84 in member 82 to the exterior of member 82 through ports 86 between sealing rings 88 and 92 and ports 90 between rings 94 and 96. The tubular hub 98 of piston 34 is also provided with a ring of ports 100 through which fluid may pass. Fluid may also flow from channel 84 into the inboard end of cylinder 36 through one or more check valves 102 arranged to open at a relatively low pressure differential between the fluid in channels 84 and in the space between the piston 34 and the inboard end of cylinder 36. Fluid at the high pressure (higher than governor control pressure) in the space inboard of the piston may flow to channel 84 through high pressure check valve 104 which prevents the flow of fluid from channel 84 to the cylinder space and also prevents the flow of fluid from the cylinder space to channels 84 until the fluid in the cylinder space has reached the high pressure.

When fluid is supplied under governor control pressure through connection 74 the fluid will enter the space at the outboard end of cylinder 36 through channel 80 and force piston 34 inboard and fluid from the space to the rear of the piston will be drained through ports 100 and channels 84 to connection 76 which will be vented to the governor pump inlet. If the supply of fluid to the front end of the cylinder is continued the piston will move inboard until ports 100 are covered by sealing ring 92, whereupon fluid will be trapped in the space to the rear of the piston and no further inboard movement of the piston can take place since the governor controlled pressure is less than the high pressure necessary to open check valve 104. The closure of port 100 by rings 92 thus constitute a low pitch hydraulic limit stop which predetermines the minimum pitch angle of a propeller blade as long as the propeller is functioning under governor control. When fluid under pressure is supplied to connection 76 and channels 84 the fluid will enter the space to the inboard side of the piston through low pressure valve 102 and force the

piston outboard while fluid in the outboard end in the cylinder will flow out through channel 80 and connection 74 which will be vented to the governor pump inlet.

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 as for example, by changing the slope of the cam which rotates the gear 24. Such a change in cam slope is indicated at 42 (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 controlled pressure, but will require the higher pressure as is applied during feathering to the operation at the rear of the piston 34.

Propeller pitch changing mechanism, therefore, operates between different predetermined low and high pitch limit stops as long as the mechanism is supplied with fluid at lower or governor controlled pressure, but the pitch may be moved beyond either of the cam limit stops by the application of hydraulic fluid at the higher pressure which is sufficient to overcome the resistance of the change in the cam slope to feather the propeller or to unseat check valve 104 to reverse the pitch. The feathering and reverse pitch operation will be described later.

The governor is shown diagrammatically in Fig. 5 to which reference is now made. The governor comprises a rotatable shaft 108 carrying gear 106 which meshes with the gear 105 carried by the engine driven shaft 14. A flange 110 which is fixed to the upper ends of shaft 108 pivotally supports a pair of fly balls 112. The shaft 108 may be made in a single piece as shown, or if desired, may comprise several sections connected together as by splined joints.

Intermediate its ends the shaft carries a gear 114 which meshes with a gear 116 supported on a hollow axle journalled in a governor base 118 to form a booster pump. Hydraulic fluid is supplied to this pump from any convenient source, the source shown herein being the engine lubricating pump 120 which is supplied through a conduit 122 from the engine oil tank or reservoir 124 and discharges through conduit 126, duct 128 and branch passage 129 to the intake of the booster pump. A relief valve 127 limits the pressure in conduit 126 and in conduit 131 leading to the engine lubricating system. Oil from the booster pump blows through check valve 130 and channel 132, through ports in a hollow shaft of 108 into annular pressure chamber 134, between annular lands 136 and 138 of a hollow piston rod of a governor pilot valve 140 which is vertically reciprocable in the hollow shaft 108 by the fly balls 112 and a speeder spring 142 which act oppositely on a flange 143 on the piston rod. When the pilot valve 140 is forced upwardly, low pressure oil supplied by the booster pump 114, 116 flows from the chamber 134 through ports in the shaft 108 to channel 144 which communicates with external fluid connection 76. When the low pressure oil is connected to fluid connection 76, the connection 74 is connected through channel 146 and suitable ports in shaft 108 between the lands 136 and 232 to the booster pump inlet channel 128, thus establishing a vent through relief valve 127 of conduit 131 for oil on the inboard side of the pitch changing piston 34. The results of admitting governor pressure fluid through connection 76, as previously described, is to move the piston 34 outboard, i. e., to increase the pitch of the blades with a resultant decrease in R. P. M. As the governor fly balls 112 slow down to permit the speeder spring 142 to depress the piston rod of valve 140 so that the land 136 cuts off the low pressure governor fluid passing from chamber 134 to channel 144 when the predetermined speed has been reached for which the governor is set.

If the governor speed falls below the predetermined value, pressure fluid in chamber 134 will be admitted past the land 138 to channel 146 and external fluid connection 74 to move piston 34 towards low pitch position while the fluid on the inboard side of piston 34 will be vented through external connection 76, channel 144 and the hollow stem of pilot valve 140 into the intake channel 128 of the governor booster pump. A relief valve 148 is provided in the governor booster pump discharge as is usual in this type of governor.

High pressure fluid is supplied to the pitch changing mechanism in the propeller hub for moving the piston 34 beyond the intermediate constant speed range above described into the special purpose ranges in which the blades are feathered in one extreme position and reversed in pitch at the other extreme position thereof. To this end a high pressure pump 150 is supplied from the reservoir 124, through conduit 152 and discharges through conduit 154 into the governor base 118.

The admission of high pressure fluid from pump 150 to opposite sides of piston 34 is controlled in part by the valve mechanism already described in the propeller hub and by the governor pilot valve. A solenoid valve 156 controls the fluid pressure to the upper side of land 216 on the piston rod of valve 140 to position the governor valve 140 to selectively admit high pressure fluid through either connection 74 or 76 leading to the pitch control mechanism in the hub. A pressure cutout switch 158 is provided for interrupting the operation of the high pressure pump 150 as will be described later. High pressure pump 150 is driven by an electrical motor 160 energized by a battery or other suitable source of power 162, through conductor 164, switch 166 and conductor 168. The electrical apparatus controlling the operation of switch 166 and solenoid valve 156 includes cutout switch 158, push-pull switch 170, toggle switch 172, and solenoid switches 174, 176, 178 and 180.

Switch 170 is normally biased by compression springs 182 and 184 into an intermediate switch open position in which the movable bridging contact 186 is held between and out of contact with two sets of stationary contacts, one of which set is engaged by the bridging member when the switch is pulled and the other of which is engaged when the switch is pushed. The movable contact member of solenoid switch 166 is constantly biased into open position by spring 183 while the movable contact member of cutout switch 158 is constantly biased into the closed position by compression spring 190. Solenoid valve 156 is constantly biased to the right as viewed in Fig. 5 by compression spring 192 while the movable switch members of solenoid switches 174, 176, 178 and 180 are biased upwardly as viewed in Fig. 5 by tension springs 194, 196, 198 and 200.

Since the supply of electrical energy in an airplane is generaly limited and the demand of the electrical deicing system and the high pressure pump 150 operating simultaneously may exceed the supply, it is found advisable to interrupt the deicing system while the high pressure

pump is operating. To accomplish this, a relay switch 390 has been inserted between the deicing timer 394 and the deicing relay 69. Relay switch 390 is normally biased upwardly by tension spring 392 as viewed in Fig. 5. This completes the circuit between battery 162, deicing timer 394, conductor 396, switch 217, conductor 398 and deicing relay 69. The interruption of the electrical deicing is accomplished by energizing solenoid 220 of relay switch 390 which is in the same circuit as that to energize the solenoid 214, for actuating motor 160 to drive the high pressure pump 150. The following description includes the interruption of the deicing system but if the electrical energy supply of the airplane is adequate, relay switch 390 may be dispensed with and deicing can take place simultaneously with the operation of high pressure pump 150.

To operate the propeller blade into feathered position, the movable switch 170 is pushed to compress spring 182 and bridge one set of stationary contacts 202, 204 and 206. This completes a circuit from the positive side of battery 162 through conduit 208, contact 206, movable bridging contact 186, to contact 202, through conduits 210, 212, to solenoid 214 of switch 166 closing the circuit to motor 160 to start the high pressure pump 150. This circuit also forms a branch circuit to de-energize the deicing system by opening switch 217 through conductor 218 for solenoid 220. The above operation of switch 170 also establishes a circuit from battery 162 through conductor 208, contact 206, movable bridging contact 186, contact 204, holding coil 222, conductors 224, 226, and contacts of switch 158.

High pressure fluid will flow from conduit 154, opening valves 233 and 235 through channel 228 and ports in hollow shaft 108, into chamber 214, between larger diameter land 216 and smaller diameter land 232 of piston rod of valve 140, thus moving the governor pilot valve upward so that high pressure fluid from conduit 154 can pass through holes 234 and channel 132 into chamber 134 within shaft 108 and thence to channel 144 and connection 76.

As previously explained, this fluid will act with sufficient force to unseat valve 102 on the inboard side of piston 34 and also to move follower members 30 into the steeper special purpose range of the cam slots to feather blades 18. As piston 34 reaches the outermost position in which the blades are feathered, it reaches the limit of travel in this direction either by the engagement of followers 30 with the ends of the cam slots 38 or by engagement of special stops which may be provided for the purpose. High pressure builds up on the discharge side of pump 150 and on the inboard side of piston 34 when the piston travel is stopped. This pressure acts through passage 236 which communicates with fluid connection 76 and chamber 238 of pressure cutout switch 158 causing movable contact 240 of this switch which is carried by piston 242 to open the circuit or holding coil 222, allowing spring 182 to return switch 170 to its intermediate open switch position. This also interrupts the circuit through solenoid 214 resulting in stopping high pressure pump 150 with propeller blades in feathered position. The engine cannot rotate the propeller in feathered position of the blades and consequently the propeller and the governor will stop rotating and the blades will remain in the feathered position until unfeathered.

In order to unfeather the blades, switch 170 is pulled to compress spring 184 and move bridging member 186 into engagement with contacts 242, 244, 246 and 248 thus establishing a circuit from battery 162 to conductor 208, contact 248, movable bridging contact 186, contact 246, conductor 250, solenoid 252, which engages the switches of solenoid switch 174, conductors 254, 256, brush 258, and electrical conductor segment 260 of control slip ring 262. A circuit is also completed from battery 162, conductor 208, contact 248, movable bridging contact 186, contact 244, conductor 264, switch 266, conductor 212, solenoid 214 of switch 166 which closes the circuit of motor 160 to start high pressure pump 150. This circuit breaks the deicing circuit as previously described by opening switch 217. Still another circuit is completed from battery 162, conductor 208, contact 248, movable bridging contact 186, contact 242, conductor 268, switch 270, conductors 272, 274, solenoid 275 of valve 156.

High pressure fluid now flows from conduit 154, through holes 234 of opened valve 233 and channel 267, through valve 156, this valve now being moved to the left to permit the fluid to pass from channel 267 through channel 269 to act on the upper side of a large diameter land 218. The high pressure fluid also flows as before through channel 228 into chamber 214 where it acts on the bottom surface of land 216 and also on the top surface of land 232. Since the fluid pressure on land 216 is balanced, the pressure on the top surface of land 232 causes pilot valve 140 to be depressed into a position such that the high pressure fluid which passes through holes 234 and channel 132 into chamber 134 is now permitted to enter the annular passage 271 which communicates with channel 146, external connection 74 leading to the outboard side of piston 34 to unfeather the blades.

To carry out the unfeathering operation during flight, the switch 170 is held out manually while the piston 34 moves the blades from the feathered position. As long as brush 258 remains in the contact area 260 of control slip ring 262 and switch 170 is held out manually the unfeathering operation will progress until the electrical conducting section area 260 is turned past the brush 258 breaking the circuit which will break the circuit to coil 252 of relay 174, shutting off the high pressure pump 150 and return the propeller to the governor control. At that time the switch 170 may be released as it no longer has any function.

To reverse the pitch of propeller blades 18, switch 172 is moved down, as shown in Fig. 7 and its movable bridging contact 276 is moved down to contact the stationary contacts 278 and 280. As a result the following circuits will be established: (1) A circuit from battery 162, conductors 282, 284, bridging contact 276, contact 278, conductors 286, 274, solenoid coil 275 of valve 156. (2) A circuit from battery 162, conductors 282, 284, bridging contact 276, contact 280, conductor 288, switch 290 of solenoid switch 176, conductors 292 and 294, solenoids 296, 298 of solenoid switches 178 and 180, respectively, conductors 300, 302, 226, and contacts of pressure cutout switch 158. The energizing of solenoid coils 296 and 298 bring switches 304 of solenoid switch 178 and switches 306 and 308 of solenoid switch 180 down into contact, as viewed in Fig. 7. When solenoid switch 178 is brought down as shown in Fig. 7, the armature 310 of solenoid 312 engages the latch 314 of armature 316 and holds solenoid switch 178 in a down or contacting position. (3) A holding circuit is now formed

from battery 162, conductors 282, 284, bridging member 276, contact 280, conductors 288, 318, switch 308, conductors 311 and 294, solenoids 296 and 298, conductors 300, 302, 226, contact points of pressure cutout switch 158; (4) A circuit from battery 162, conductors 282, 320, 322, switch 304, conductor 324 and solenoid 326. This circuit will bring solenoid switch 176 down into the position shown in Fig. 8 opening circuit (2) as a result of opening switch 290. The holding circuit (3) now maintains switches 178 and 180 down. (5) A circuit is now established from battery 162, conductors 282, 320, 328, switch 306, conductors 330, 332, switch 334, conductor 336, and solenoid 214 to close the circuit to motor 160 for driving high pressure pump 150. This circuit also interrupts the deicing circuit as previously described.

High pressure fluid is now supplied from conduit 154 (Fig. 5 through holes 234 of opened valve 233, valve 156 and conduit 269 to the upper side of land 216. High pressure fluid also passes through channel 228 to chamber 214 where it acts on the upper surface of land 232 and on the lower surface of land 216. Pilot valve 140 consequently moves downward to permit the high pressure fluid from chamber 134 into annular passage 271 and communicating channel 146 and external connection 74.

When the cam followers 30 have reached the inboard ends of the cam slots or when the reverse pitch stops are engaged, if such stops are employed, the pressure on the outboard side of piston 34 and the conduits leading thereto builds up to the full pressure developed by the high pressure pump 150. This pressure in conduit 146 is transmitted to the fluid in a channel 338 to act on the right-hand end of valve 340 and move the latter to the left admitting fluid to the chamber 238 of the pressure cutout switch 158 and cause the switch to open its contacts and interrupt the holding coil circuit for switch 180. Switch 180 will therefore move to its normal open position shown in Fig. 9 when the blades have reached the reversed pitch position and as a result circuits 3 and 5, previously described, which were completed by moving switch 172 downwardly will be opened.

Means is provided for maintaining circuit (1) energized upon completion of reversing. This circuit, it will be recalled, consists of battery 162, conductors 282 and 284, bridging contact 276, contact 278, conductors 286, 274, solenoid coil 275 of valve 156. This is necessary to permit the low pressure fluid from the governor booster pump to flow through check valve 130, channel 267, valve 156, channel 269 to the upper side of land 216 which will keep the governor pilot valve 140 in the down position and maintain the propeller in reverse pitch.

Switch 178 is maintained in the down position by the engagement of armature 310 of solenoid 312 engaging the latch 314 of armature 316 of switch 178. This is necessary to secure during subsequent unreversing a circuit to the solenoid 214 to operate switch 166 and turn motor 160 to drive high pressure pump 150. This is circuit 4, previously described, which energizes solenoid 326 of switch 176 and maintains switch 334 in the down or contact position. These circuits are shown in Fig. 9.

To unreverse the propeller blades, the switch 172 is moved up (as shown in Fig. 5) causing the bridging contact 276 to contact contacts 342 and 344. Moving bridging contact 276 breaks circuit 1, as previously described, which returns valve 156 to the position shown in Fig. 5. Moving the bridging contact 276 upward establishes a circuit from battery 162 through conductors 282, 284, bridging contact 276, contact 344, conductors 336, 332, switch 334, conductor 336 and solenoid 214 to close the circuit to motor 160 for driving the high pressure pump 150. This circuit also interrupts the deicing circuit as previously described.

The hydraulic functioning is the same as that previously described for feathering. When the blades are in the reverse pitch position, the brush 258 is at the R position of control slip ring 262. As the blade progresses out of the reverse pitch position towards the constant speed range, the brush will be in contact with a nonconducting insulating segment 346 of control slip ring 262. After the blades, in their unreversing movement, pass LP (low pitch position), the brush 258 will contact conducting segment 348 of control slip ring 262. As this contact is made a circuit from battery 162, conductors 282, 284, bridging contact 276, contact 342, conductor 350, solenoid 312, conductors 352, 256, brush 258, segment 348 will be established. This circuit will energize solenoid 312 retracting armature 310 from the latch 314 of armature 316 of switch 178. This will open previously described circuit 4. Opening this circuit will de-energize solenoid 326, releasing switch 176 permitting it to return to the up position as shown in Fig. 5 and opening the circuit to solenoid 214 which shuts off the power to motor 160 and high pressure pump 150. This stops the action of the high pressure fluid and returns the propeller to normal governor operation. Switch 172 and its bridging member 276 remain in their up position as viewed in Fig. 5 with all circuits de-energized.

It will be evident that as a result of this invention a particularly simple and reliable means has been provided which is entirely automatic for returning the propeller to governor operation following unfeathering and unreversing operation. It will further be evident that the improved means above-described insures that the propeller will be subjected to high pressure fluid only during the short time that it is actually required for moving the blades in the special purpose ranges. It will also be evident that an excessive electrical demand will not be imposed upon the airplane electrical system if it cannot accommodate both the deicing system and operation of the high pressure fluid pump simultaneously by interrupting the former while the latter is operating and only then. It will be further noted that the improved means of this invention for returning the control to the governor, does not require the attention of the pilot during unfeathering to release switch 178 at the particular time to prevent overspeeding of the engine, as the unfeather means is automatically discontinued when the propeller has returned to the governor range. It will be further noted that the improved means of this invention for returning the control to the governor does not require the attention of the pilot during unreversing, the only action required of the pilot being the moving of toggle switch 172 to the unreverse position to initiate the unreversing operation.

While several embodiments of the invention have been shown and have been described and illustrated in the accompanying drawings, it will be understood that these particular embodiments of the invention are shown for purposes of illus-

tration only and that deviations in the construction and operation of the mechanism may be made without departing from the spirit and scope of the invention as defined in the appended claims.

What it is desired to be secured by Letters Patent is:

1. In combination with a propeller having controllable pitch blades, a governor for controlling the pitch of said blades within a predetermined range, manually controlled means connected with said governor and said blades for disabling control by said governor control and including means for moving said blades beyond said range and for returning said blades to said range and electrically actuated means connected with said manually controlled means and said blades and controlled by said blades for automatically disabling said manually controlled means and automatically returning said propeller to governor control when said blades pass into said range from beyond said range.

2. In combination with a propeller having controllable pitch blades, electrical means for deicing said blades, means for varying the pitch of said blades in a normal range of operation, electrically energized means including mechanism for moving said blades beyond said normal range, a circuit breaker connected with said deicer and said electrically energized means and automatically actuated by energization of said mechanism to maintain said electrical deicing means inoperative while said electrically energized means is energized.

3. In combination, a propeller having variable pitch blades, a fluid operating pitch changing motor therefor, electrical means for deicing said blades, a governor controlling the admission of fluid to said motor to vary the pitch of said blades in a normal operating range of pitch variation, electrically actuated means for supplying fluid to said motor at a pressure higher than the governor controlled fluid for moving said blade into and out of a special purpose range beyond said governor control range, and a circuit breaker connected with said electrically actuated means automatically interrupting said electrical deicing means incident to energization of said electrically actuated means to provide pitch changing operation of said blades in said special purpose range.

4. In combination with a propeller having controllable pitch blades, a pitch changing motor therefor, a governor controlling said motor through a normal pitch changing range, electrically actuated means for controlling said pitch changing motor in a special purpose range beyond said normal means, an electrical deicing system for said blades including blade deicing elements carried by said blades, a brush carried by said propeller and a slip ring carried by said blades and contacting said brush and connected with said deicing elements and said electrically actuated means for transmitting electrical energy to said blade deicing element and controlling said electrically actuated means, said blade slip ring having an insulated segment corresponding to said special purpose range for interrupting the flow of electrical energy to said electrically actuated means.

5. In combination with a propeller having controllable pitch blades, electrical blade deicing means for deicing said blades, a speed responsive governor operatively connected with said blades for controlling the pitch of the blades within a predetermined range in accordance with speed, manually controlled electrically actuated means connected with said governor and said deicing means for disabling said governor control and said electrical deicing means and moving said blades beyond said range and for returning said blade to said range, electric means operatively connected with said blades, said deicing means and said electrically actuated means and responsive to pitch changing movement of said blades in changing pitch from beyond said range into said range for disabling said manually controlled electrically actuated means, automatically restoring operation of said electrical deicing means and returning said propeller to governor control.

6. In a controllable pitch propeller having a normal pitch range and a special purpose range and having electrical deicing means associated with the propeller blades, a slip ring carried by the blade and a brush cooperating with said ring forming part of the deicer circuit, propeller pitch control means including electrically actuated mechanism for changing the blade pitch in said special purpose range, insulation, associated with said ring carried by said blade, forming signal creating means, signal receiving means forming a part of said propeller pitch control means, said brush and slip ring forming a part of the signal transmitting circuit connecting said brush and said signal receiving means and means actuated by said signal receiving means disabling said electrically actuated mechanism.

7. In a controllable pitch propeller having a normal pitch range and a special purpose range and having electrical deicing means associated with the propeller blades, a slip ring carried by the blade and a brush cooperating with said ring and forming part of the deicer circuit, propeller pitch control means including a governor for controlling the blade pitch in said normal range and electrically actuated mechanism for changing the blade pitch in said special purpose range, said slip ring having non-conducting portions at selected segments of said ring forming signal creating means, said electrically actuated mechanism including signal receiving means actuated by interruption of electrical current through said deicer ring to de-energize said electrically actuated mechanism.

8. In a controllable pitch propeller having a normal pitch range and a special purpose range and having electrical deicing means associated with the propeller blades, a slip ring carried by the blade and a brush cooperating with said ring forming part of the deicer circuit, propeller pitch control means including a governor for controlling the blade pitch in said normal range and electrically actuated mechanism for changing the blade pitch in said special purpose range, said slip ring having non-conducting portions at selected segments of said ring forming signal creating means, said electrically actuated mechanism including signal receiving means actuated by establishing an electrical current through said deicer ring to de-energize said electrically actuated mechanism.

9. In a controllable pitch propeller having a normal pitch range and a special purpose range and having electrical deicing means associated with the propeller blades, a slip ring carried by the blade and a brush cooperating with said ring forming part of the deicer circuit, propeller pitch control means including a governor for controlling the blade pitch in said normal range and electrically actuated mechanism for changing the blade pitch in said special purpose range, said slip

ring having non-conducting portions at selected segments of said ring forming signal creating means, said electrically actuated mechanism including signal receiving means actuated by interruption of electrical current through said deicer ring to de-energize said electrically actuated mechanism when said blades enter said normal pitch range from one direction and actuated by establishing an electrical current through said deicer ring to de-energize said electrically actuated mechanism when said blades enter said normal range from the other direction.

10. In combination with a propeller having controllable pitch blades, a pitch changing motor therefor, a governor connected with said motor for controlling the pitch of said blades in the normal range of pitch variation, electrically controlled means connected with said governor and energizable to disable said governor and operate said blades in pitch changing movement beyond said normal range in feather or reverse pitch range, means carried by said blades for making and breaking electrical circuit in said electrically controlled means, means responsive to breaking said circuit for de-energizing said electrically controlled means, means responsive to making said circuit for de-energizing said electrically controlled means, and means responsive to de-energizing said electrically controlled means for automatically returning said motor to governor control, said circuit making and breaking means adapted to break a circuit, interrupt said electrically controlled means, and automatically return said motor to said governor control when said blades pass from said feathering range to said normal range, said circuit making and breaking means adapted to make a circuit, interrupt said electrically controlled means and automatically return said motor to said governor control incident to passage of said blades from said reverse pitch range to said normal range.

11. In combination, a propeller having variable pitch blades, a hydraulic pitch changing motor therefor, a governor controlling the admission of fluid to said motor in a normal operating range of pitch variations, a source of fluid pressure, means for selectively connecting said source with said motor to move said blades beyond, and return the blades to, the conveyor control range, pressure responsive means hydraulically connected with said source, other means connecting said pressure responsive mean and said source for controlling said fluid pressure source, electrical means operatively connected with said source for controlling said fluid pressure source, means for creating a pressure surge in said fluid from said source to actuate said pressure responsive means and disable said source when said propeller blades reach feathered position and reversed position and means actuated by movement of said blades for operating said electrical means and automatically disabling said source incident to movement of said propeller blades from feathered position and reverse position to said operating range.

12. In combination, a propeller having variable pitch blades, a hydraulic pitch changing motor therefor, an electrical means for deicing said blades, a governor controlling the admission of fluid to said motor in a normal operating range of pitch variation, a source of fluid pressure, means for connecting said motor with said source for operating said motor to move said blades beyond the governor control range, pressure responsive means connected with said source for controlling said fluid pressure source, a second electrical means connected with said source for controlling said fluid pressure source, means for creating a pressure surge in said fluid from said source to actuate said pressure responsive means and disable said source when said propeller blades reach feathered position and reversed position and means responsive to movement of said propeller blades from feathered position and reverse position to said operating range for automatically actuating said second electrical means to disable said source, and means responsive to operation of the pitch changing motor to move said blades to feathered position and reversed position and responsive to operation of the pitch changing motor to move said blades from feathered and reversed position to said normal operating range for automatically interrupting the flow of electricity to said electrical deicing means.

13. In combination with a propeller having controllable pitch blades, a pitch changing motor therefor, a governor controlling said motor in a normal range of pitch change, electrically controlled means for operating said motor beyond said range into and out of reverse pitch, a slip ring carried by said blade, a brush carried by said propeller contacting said slip ring, said slip ring having an insulated segment corresponding to reverse pitch range, manually actuated control means for energizing said electrically controlled means to move said blades to reverse pitch position, manually actuated means to initially energize said electrically controlled means to move said blades from reverse pitch position toward said normal range, an electrically actuated circuit breaker for breaking the circuit to said electrically controlled means, said circuit breaker being actuated upon contact of said brush with the uninsulated portion of said slip ring, said insulated segment maintaining said circuit breaker inoperative by insulating said brush from said slip ring during a selected blade pitch range, and said circuit breaker being actuated to interrupt said electrically controlled means when said brush no longer contacts said insulating segment.

14. In combination, a propeller having variable pitch blades, a hydraulic pitch changing motor therefor, a governor controlling the admission of fluid to said motor in a normal operating range of pitch variation, a source of fluid pressure means connecting said source with said motor for operating said motor to move said blades beyond said governor controlled range in feathered and reverse pitch ranges, electrical control means for controlling said fluid pressure source, means actuated incident to movement of said blades to feathered and reverse pitch positions for automatically actuating said electrical control means to render said source ineffective to change blade pitch when said blades have been moved by said motor to feathered position and reverse pitch position and means actuated incident to return of said blades to normal position for automatically actuating said electrical control means to render said source ineffective to change blade pitch when in the unfeathering movement and unreversing movement said blades reach predetermined positions in the normal governor controlled pitch range.

15. In a control for a controllable pitch propeller blade comprising a hydraulically actuated pitch changing motor, a source of fluid supply, a governor having a governor valve for controlling the flow of fluid from said fluid supply to said motor to maintain substantially constant

propeller speed; governor valve moving means connected with said governor valve, a second source of fluid supply including an electrically actuated pump, electrically actuated valve means for directing fluid from said second source to said governor valve moving means to selectively move said governor valve to direct fluid from said second source to one side or the other of said motor, a slip ring having conducting and insulating portions and movable in timed relation with said blade, a switch and connections for completing the electrical circuit to said electrically actuated pump, including a connection through said slip ring, said insulated portion breaking said connections and stopping said pump when the blade reaches a predetermined position.

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