

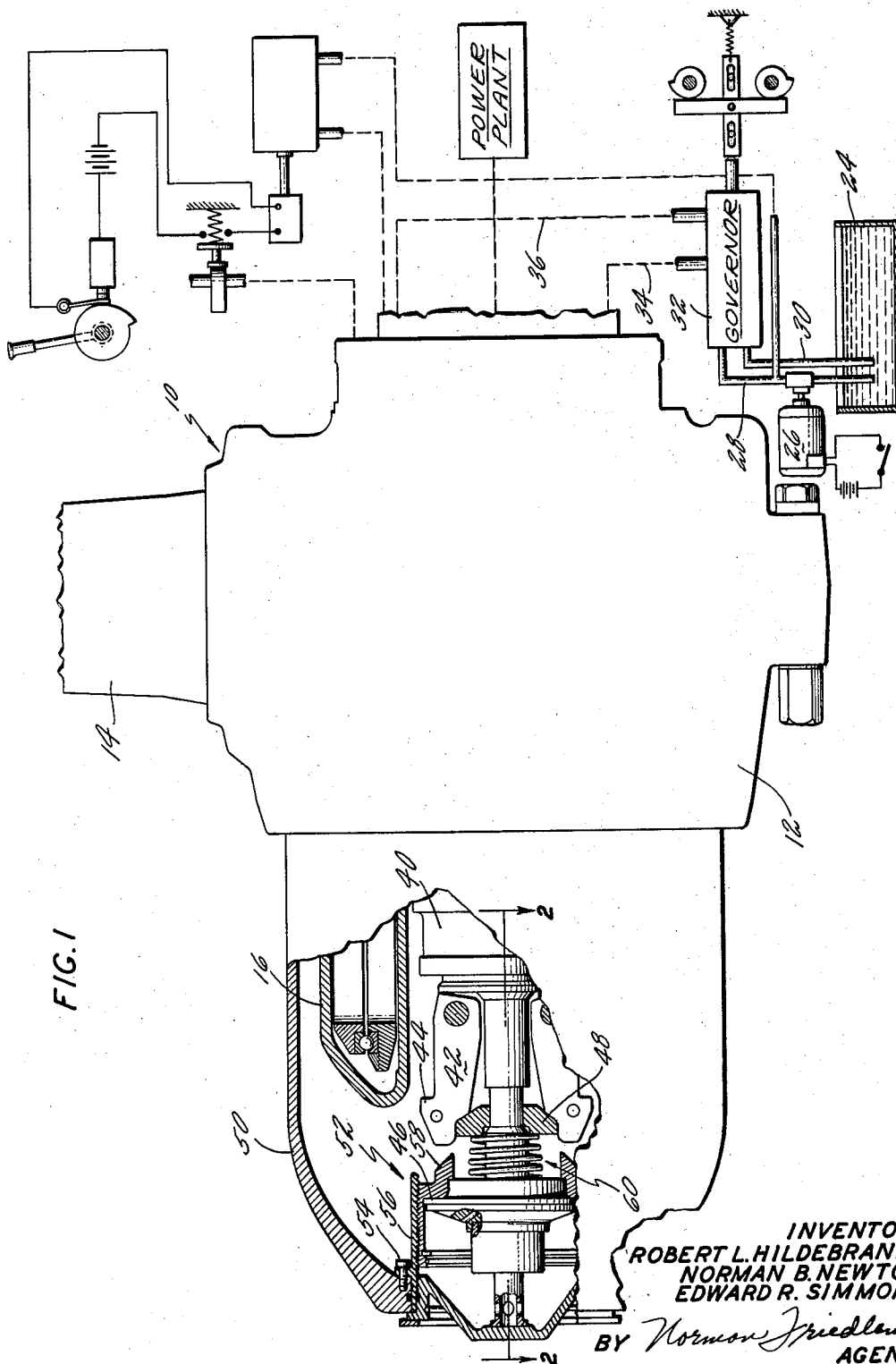
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AND LOW PITCH STOP SERVO VALVE

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2 Sheets-Sheet 1



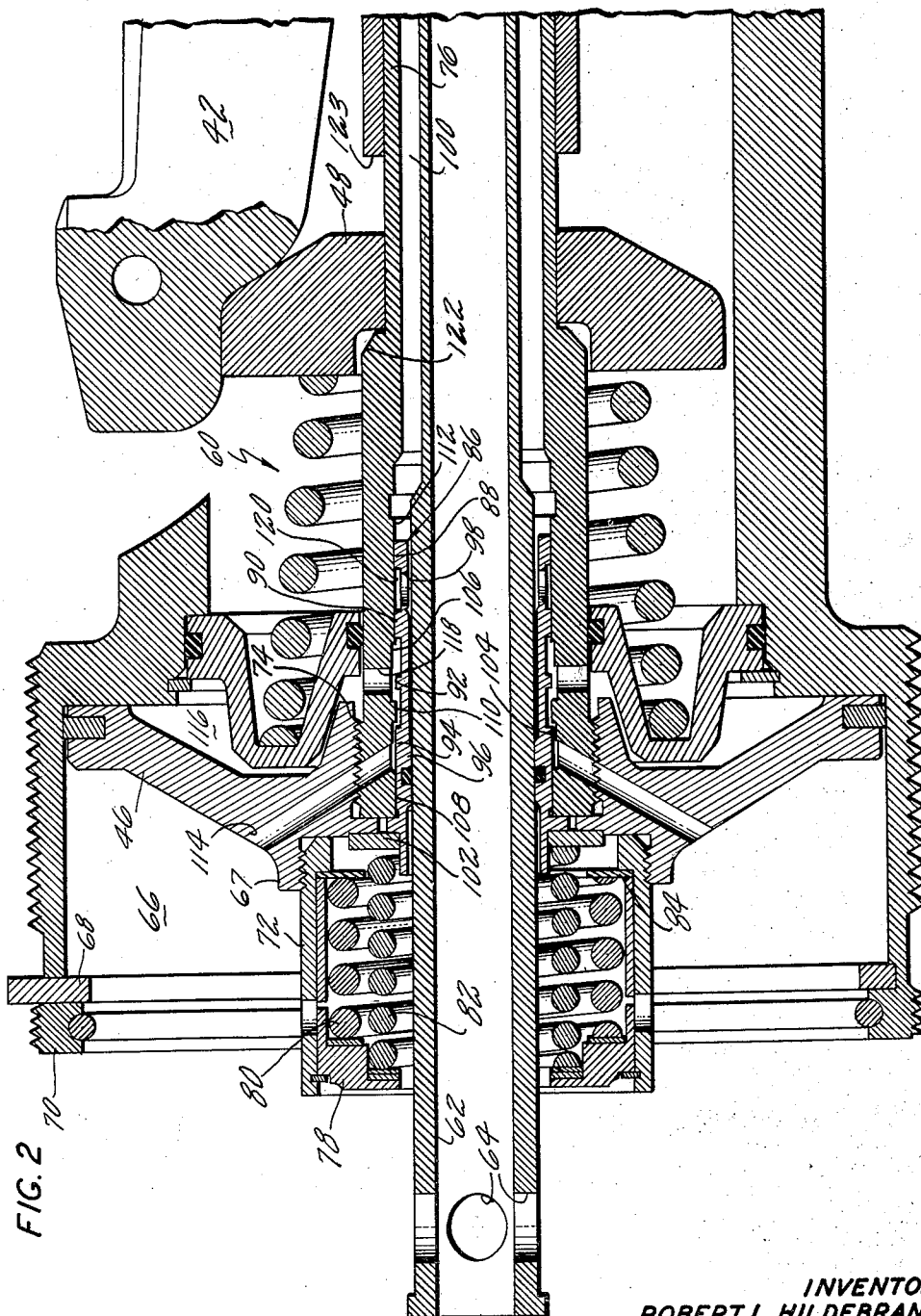
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AERONAUTICAL PROPELLER WITH COMBINED SURGE AND LOW PITCH STOP SERVO VALVE

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This invention relates to variable pitch propellers and particularly to surge and low pitch stop servo systems for such propellers and is an improvement on the surge and low pitch stop servo valves disclosed in Patent No. 2,477,868 and patent application Serial No. 10,435 filed February 23, 1960 and assigned to the same assignee.

An object of this invention is mechanism combining the surge and the low pitch stop servo control functions.

A further object is to provide for the propeller as described a single valve operable over two different force levels wherein when in one of the force levels the valve serves to control the position of the low pitch stops, and when in the other level the valve serves as a pressure relief valve.

A still further object is to provide for a system as described a single valve for performing two functions which is characterized as being economical to manufacture, highly reliable, yet capable of rugged use, affords simplicity over the existing mechanism, and is lighter in weight.

Other objects and advantages of this invention will be apparent from the following specification and accompanying drawings in which:

FIG. 1 is a partial cross section, partially schematic, of a controllable pitch propeller incorporating the invention.

FIG. 2 is an enlarged detailed cross section taken along line 2—2 of FIG. 1 and particularly showing the details of the invention.

In the interest of reducing the cost and weight of the propeller, we have found that modifying the customary servo control valve for the low pitch stop in such a manner as to incorporate the functions of the surge valve, the surge valve can be entirely eliminated. Thus, by these provisions, a single valve may be employed instead of two valves heretofore employed while still retaining the functions of both valves. Examples where both a surge valve and a servo control valve are used may be found in the above-referred-to Patent No. 2,477,868 and patent application Serial No. 10,435 filed February 23, 1960, assigned to the same assignee, as well as Patent No. 2,928,977 and the Pond application Serial No. 843,114 filed September 29, 1959, assigned to the same assignee and now issued as Patent No. 3,037,560. As is well known in the art, the servo control valve for the low pitch stop serves to retract the low pitch stop for allowing the propeller to move to a reverse position. The surge valve serves to relieve excessive pressure evidenced in the low pitch side of the pitch changing motor which is occasioned during pitch reverse operation. As for example, the low pitch pressure level may reach 250 p.s.i. when low pitch stop pistons are actuated for retracting the low pitch stop in the reversing operation, and this pressure may build up in excess of 600 p.s.i. during this operation. The surge valve operates to relieve this pressure to prevent the pressure from exceeding this value so as to prevent damage to the operation mechanism.

Referring now to FIGURE 1, the propeller is generally indicated at 10 including the barrel 12 which supports a plurality of variable pitch blades 14. The blades 14 are mounted for pitch changing movement within the barrel

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12. The pitch changing piston 16 is provided for movement by hydraulic pressure in the forward and aft direction. This forward or aft movement is ultimately transformed into a rotary movement in a well-known manner for rotating blades 14 about their longitudinal axis. For details of suitable mechanism reference is hereby made to the above-referred-to Newton application Serial No. 10,435. A pitch changing mechanism includes a fluid reservoir from which fluid is pumped by a motor pump combination 26 or a propeller driven pump through a line 28 and eventually returning to the reservoir via line 30. A suitable governor 32 is provided and directs a flow of fluid under pressure to the low and high pitch lines 34 and 36 respectively. Low pitch pressure is directed to the fore and aft end of the pitch changing motor 16 through suitable passages not shown. For further details of pitch changing mechanisms, attention is invited to U.S. Patent Nos. 2,653,668 and 2,758,659.

The pistons carry sleeve 40 which slides over pitch stop levers 42 when the piston moves in the fore direction. Since the piston determines the rotational movement, that is the pitch changing movement of the blades, the relative position of the piston is, therefore, indicative of the pitch of the blades. Thus, when pitch changing piston 16 moves forward, the sleeve 40 will slide over the rear portion of lever 42 and eventually engage the upstanding portion 44 of stop lever 42. When the edge of sleeve 40 engages upstanding member 44, the pitch of the blades will be in the extreme low pitch position. Retraction of the low pitch stop will permit the sleeve and hence piston to move in a more forward position thus allowing the blade to move into a negative blade angle which hereinafter is referred to as the reverse position.

In essence, to allow the blades of the propeller to move in the reverse position high pressure fluid is directed to the aft side of low pitch stop servo piston 46 which permits wedges 48 to move out from under the stop lever and hence allow the stop to retract inwardly.

Still referring to FIGURE 1, dome 50 encases the propeller operating mechanism including the low pitch stop assembly generally indicated by numeral 52 and including the servo control valve generally indicated by numeral 60. The dome terminates in an opening in its forward end which has normally attached thereto dome cap 54 which may be easily removed for accessibility inside the dome. An inwardly extending sleeve 56 is attached concentrically with the opening at the dome and may be fixed thereto by bolt 54. The sleeve is internally threaded and receives an externally threaded support member 58 which supports the low pitch actuating piston 46. As will be more fully described hereinbelow, piston 46 is controlled by the control valve 60.

Now referring to FIGURE 2, which shows in detail the present invention, transfer tube 62 extends through the dome for communicating fluid passing through the governor (see FIG. 1) through port 64 to the high pitch or foreside of the pitch changing piston. As noted the same fluid pressure also acts on the foreside of the piston 46. Piston 46 is axially movable with respect to the transfer tube in chamber 66 and the extent of its travel is governed by washer 68 which is retained by ring 70. The ring having external threads engages the internal threads of sleeve 56. The piston carries at its fore end the threaded flange member 67 which engages the external threads formed on spring retaining sleeve 72. Formed on the aft end of the piston is internally threaded portion 74 engaging an external thread formed on the hollow shaft 76. Thus, from the foregoing, it is apparent that sleeve 72 and shaft 76 are rigidly connected to piston 46 so that rectilinear movement imparted thereto will impart like movement to the sleeve and the shaft. Sleeve 72 has internally fixed therein spring retainer 78 which

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supports coaxially mounted springs 80 and 82. A ring 84 is supported to the inner portion of the sleeve for bearing against the free end of spring 80.

Interposed between the shaft 76 and transfer tube 62 is control valve 86. In accordance with the present invention this control valve serves to meter fluid to actuate the low pitch stop piston 46 as well as to relieve pressure from the low pitch side of the pitch change motor in the event it goes beyond a predetermined value, say 600 p.s.i. In the preferred embodiment control valve 86 comprises four outer lands 88, 90, 92, and 94, inner land 96, and port 98. Thus, as will be noted from the drawing, between the inner land 96 and the right hand of valve 86 the valve is spaced from the transfer tube. This allows communication of fluid between low pitch passage 100 formed between the hollow shaft and the transfer tube and port 98.

An upstanding ring member 102 is carried by the left end of control valve 86 and is subject to the force of spring 82 in the position shown in the drawing. Thus, it will be appreciated that in its present position, valve 86 is subjected to the force of the low pitch fluid acting on its right end and the force of the high pitch fluid as well as spring 82 acting at its left end.

The shaft has formed on its inner diameter annular grooves 104 and 106 and lands 108, 110, and 112. When the pitch change piston is in the position shown in the drawing, the angle of the propeller blades is in the positive pitch regime and while in this regime, piston 46 is in the extreme right position and land 92 is spaced intermediate lands 110 and 112. Passages 114 are formed in the piston 46 to conduct high pitch fluid from chamber 66 to chamber 116 formed on the aft side of piston 46 via annular grooves 104, 106, and port 118. Thus, it will be appreciated that since the area of the piston on the foreside is larger than the area of the piston on the aft side, the piston will be held in the extreme right position. Return springs (not shown) may engage the shaft 76 for aiding the forces acting on piston 46 to provide a positive force for urging the piston and low pitch stop in its normal position as shown. For a more detailed description of adequate return springs reference is hereby made to the above-referred-to Lambeck Patent Nos. 2,928,477 and 2,843,212.

When the reverse position is desired, high pressurized fluid in a well-known manner is supplied to passage 100 and conducted to act on valve 86. Since the force acting on the right end of the valve now exceeds the combined force of the fluid and the spring acting on the other end, the valve translates to the left to place land 92 adjacent to land 110 and to place land 90 to the left of land 112. This serves to block the passage conducting chambers 66 and 116 and simultaneously open chamber 116 to passage 100 via port 98, annular groove 106 and port 118. The increased pressure acting on the aft side of piston 46 causes the piston to move toward the left and as described above, carries therewith sleeve 72 and shaft 76 as well as control valve 86. Thus, it is apparent that the relative position of the control valve with respect to the piston 46 is dictated solely by the spring and fluid pressure forces. Also, the relative position of the control valve with respect to the transfer tube is dictated by the aforementioned forces as well as piston 46. Movement of piston 46 causes abutment 122 formed on shaft 76 to move away from wedge 48 while abutment 123 (aft of wedge) moves to the left carrying wedge with it, allowing the stop levers 42 to move inwardly and hence sleeve 40 (see FIG. 1) to move past the upstanding portion 44 of stop lever 42 allowing the blade to move into reverse position.

In the event that the pressure evidenced in passage 100 exceeds a predetermined value as established by springs 82 and 80 relief valve 86 continues to move toward the left so that ring 102 abuts against member 84. This serves to communicate the low pitch pressure with the high pitch pressure. It will be appreciated that valve

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86 compresses spring 80 to allow land 92 to move to the left of land 110 and simultaneously land 90 moves to the left of land 112 so that there will be uninterrupted communication between passage 100 and chamber 66 via the clearance between valve 86 and transfer tube 62, port 98, annulus 120 and passage 114. As pointed out above, since chamber 66 is subjected to high pitch pressure and since passage 100 is subjected to low pitch pressure, the low pitch pressure communicates directly with the high pitch pressure to prevent low pitch from exceeding a predetermined value, namely 600 p.s.i. In this position the valve now serves as a pressure relief function.

To return the blade in the positive pitch range, the low pitch pressure is reduced in a well-known manner so that the cooperative of springs 80 and 82 acting on valve 86 returns the valve to its original position allowing the piston 46 to reach equilibrium. The cam portion of shaft 76 is repositioned to the position shown in the drawings allowing the wedge to return to the position shown in the drawings. The return springs (not shown) mentioned above assure that the wedge and low pitch stop assembly are returned to the normal position as shown in the drawings.

What has been described by this invention is improvement to the servo valve which is adapted to serve the dual functions of controlling the servo piston 46 for low pitch stop condition and prevent excessive pressure, i.e. surge. It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departing from its spirit as defined by the following claims.

We claim:

1. In an aeronautical propeller having,

(1) reversible pitch blades mounted about the axis of rotation of said propeller,

(2) means including a stop member for preventing said blades from advancing to reverse,

(3) fluid actuated means for retracting said stop member to allow said blades to reverse,

(4) a control valve for controlling the flow of fluid to said fluid actuated means,

(5) said control valve also including means for relieving the pressure of fluid acting on said actuating means upon reaching a predetermined value.

2. In a variable pitch propeller having,

(1) a fluid actuated pitch change motor,

(2) fluid control means varying the position of said pitch change motor,

(3) low pitch stop means for preventing said pitch change motor from moving below a predetermined pitch value,

(4) said low pitch stop means comprising,

(a) a servo piston, and

(b) a fluid control valve for controlling the position of said servo piston,

(5) said fluid control valve including means responding to the pressure of fluid acting on one side of said pitch change motor and having openings connected to either side of said pitch change motor for conducting the pressure from one of said sides to the other upon reaching a predetermined value.

3. In a variable pitch propeller,

(1) a fluid actuated pitch change motor for advancing the pitch of the blades through a negative and positive pitch range,

(2) a source of fluid under pressure,

(3) coordinating control means for regulating the flow of fluid from said source to said pitch change motor,

(4) a low pitch stop means for preventing the pitch change motor from advancing through the negative pitch range,

(5) a movable piston for retracting said low pitch stop for allowing the pitch change motor to advance through the negative pitch range,

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(6) valve means having two positions, a fluid control function for positioning said piston and a fluid pressure relief function for relieving the pressure acting on said pitch change motor upon reaching a predetermined value,

((a) said valve means being responsive to a pressure for moving said valve in one of said positions for directing fluid to act against said movable position,

(b) and said valve means being responsive to a pressure whose value is higher than the last mentioned pressure for directing fluid from one side of the pitch change motor to the other side of said pitch change motor.

4. In an aeronautical propeller for a pitch change motor including pitch control coordinating mechanism in combination with means for reversing the propeller and relieving the pressure in the pitch change motor comprising a source of fluid under pressure, a low pitch stop for preventing the blades from going below a predetermined low pitch position, a servo actuated piston retracting said low pitch stop, said means including a combined servo control and a pressure relief valve, said servo control and pressure relief valve responsive to the pitch control coordinating mechanism for regulating flow of fluid from said source to said servo actuated piston and said servo control and pressure relief valve also responsive to the pressure acting on said pitch change motor for directing the fluid from one side of said pitch change motor to the other side of said pitch change motor when said pressure reaches a predetermined value.

5. In a variable pitch propeller for a pitch change motor for varying the pitch of the propeller blades, a source of fluid under pressure, an elongated transfer tube extending through the propeller for directing fluid from said source to one side of the pitch changing piston,

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an elongated sleeve coaxially mounted relative to said transfer tube and defining therewith an annular passage for conducting fluid from said source to the other side of said pitch changing mechanism, means including a servo actuated piston for allowing the blades to move in a reverse position, valve means disposed in said annular passage for directing fluid in said annular passage to one side of said servo actuated piston, said valve means including an elongated spool member surrounding said transfer tube and having a plurality of lands, one of said lands for normally blocking off the flow of fluid from one side of the pitch changing mechanism to the other side of the pitch changing mechanism, said spool having one end responsive to the pressure of the fluid acting on one side of the pitch changing member, resilient means acting on an opposite end of said spool member for opposing the pressure acting on the opposite end thereof, a passage formed in said servo actuated piston for leading fluid from one side of the pitch changing motor to said valve means, said spool movable to uncover said one land for directing fluid from one side of said pitch changing motor through said passage through said valve to the other side of said pitch change motor.

6. In a variable pitch propeller as claimed in claim 5 wherein said resilient means includes coaxially mounted springs acting against one end of said spool member.

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