May 30, 1939. E. MARTIN 2,160,025

HYDRAULIC CONTROL MECHANISM

Filed Nov. 7, 1934 2 Sheets-Sheet 1

Fig. 1

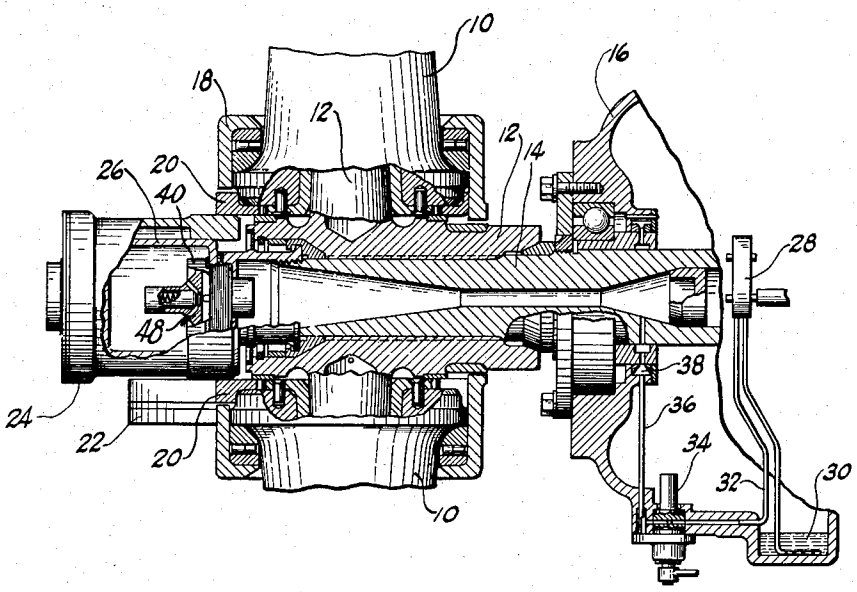
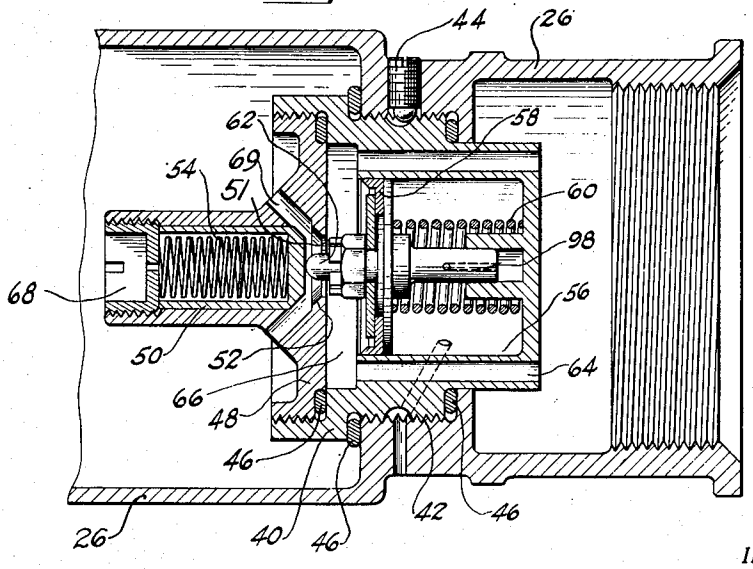


Fig. 2



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HYDRAULIC CONTROL MECHANISM

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Fig. 3

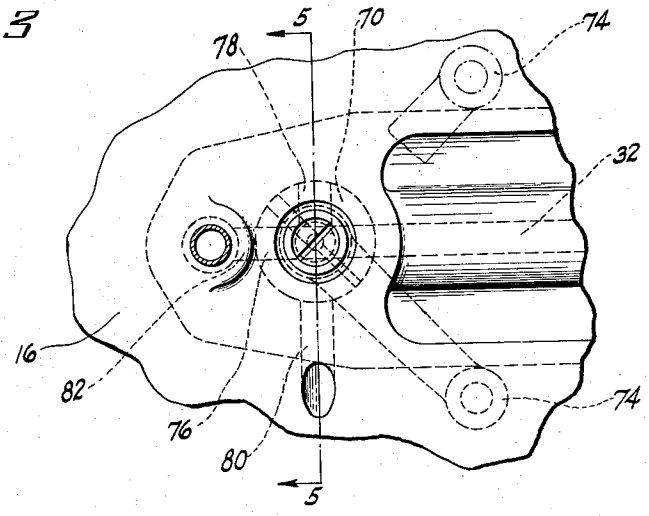


Fig. 4

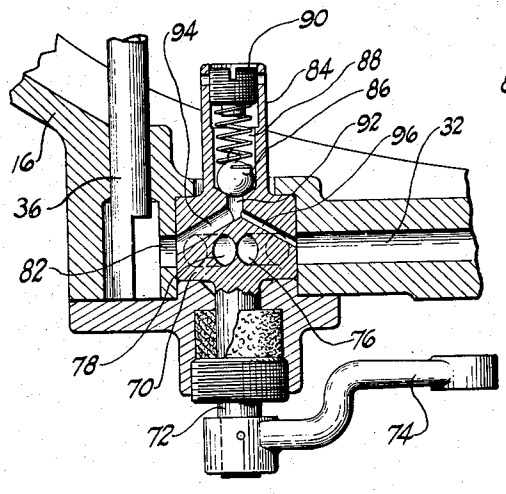
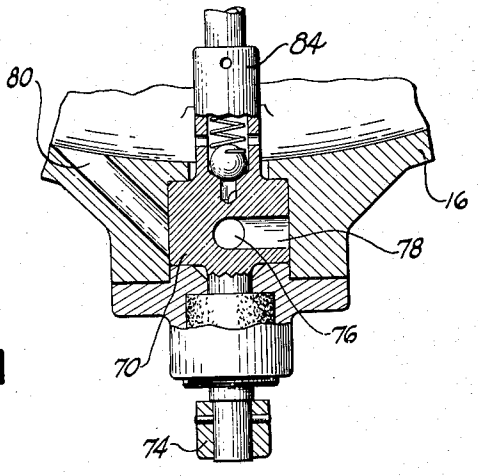


Fig. 5



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UNITED STATES PATENT OFFICE

2,160,025

HYDRAULIC CONTROL MECHANISM

Erle Martin, West Hartford, Conn., assignor, by mesne assignments, to United Aircraft Corporation, a corporation of Delaware

Application November 7, 1934, Serial No. 751,855

20 Claims. (Cl. 170—163)

This invention relates to a hydraulic control mechanism and particularly to control mechanism for a controllable pitch propeller.

In controllable pitch propellers of the hydraulic type means are usually provided for obtaining only two pitch positions, namely, a high pitch position and a low pitch position. These positions may, however, be obtained during flight at the will of the operator. It is sometimes desirable to be able to obtain a propeller pitch setting of some intermediate value or to adjust the propeller pitch by small increments during flight.

It is an object of my invention to provide a mechanism for controlling the pitch of propellers.

Another object of my invention is to control the intermediate pitch settings of hydraulic controllable pitch propeller normally having a high and a low pitch setting.

Another object of my invention is to provide a valve mounted on a rotating shaft and controlled by a stationary valve outside the rotating shaft.

Another object of my invention is to supply hydraulic fluid under pressure to propeller pitch actuating means, drain the fluid from said means or hold the fluid in said means.

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

Figure 1 is a side elevation, partly in section, of the hub portion of a propeller and a portion of an engine showing my invention incorporated therein.

Figure 2 is an enlarged detailed view of the propeller control valve.

Figures 3, 4, and 5 are detailed views of the pressure control valve.

This invention is shown as applied to an engine-propeller combination similar to that shown in Patent No. 2,032,255 issued February 25, 1936 to F. W. Caldwell. The propeller blades 10 are mounted upon a spider 12 which in turn is mounted up and driven by the engine shaft 14 supported in the engine front portion 16 usually forming part of the engine crankcase. The propeller blades are restrained against outward movement by means of the hub barrel 18. Brackets 20, secured to the inner end of the blades, carry counterweights 22 at the outer ends thereof and are adapted to turn the blades under the action of centrifugal force. The counterweights 22 are connected by pin and cam connections (not shown) to the actuating cylinder 24. This actuating cylinder is mounted to reciprocate on a piston 26. Fluid pressure may be supplied through the piston to the interior of the actuating cylinder 24, to move that cylinder outward and thereby move the counterweights inwardly against the action of centrifugal force, to turn the blades to either high or low pitch position. In the embodiment illustrated this turns the blades to low pitch position. When the pressure within the cylinder is released, the counterweights act to turn the blades to high pitch position and by moving the cylinder 24 inwardly force the fluid out of the interior of that cylinder.

Fluid under pressure is supplied to the actuating cylinder from the engine lubricating system, which supplies oil under pressure to the various parts of the engine to be lubricated, but any other convenient source of pressure may be used. In the embodiment shown, the pump diagrammatically shown at 28 pumps oil from a sump or reservoir 30 and discharges it under pressure to pipe 32. This pipe connects with a valve indicated as 34 for controlling this oil. This valve is connected by a pipe 36 with a collector ring generally indicated at 38 by means of which oil is introduced to the interior of the hollow shaft 14 on which the propeller is mounted. The oil is thus led through the shaft to the interior of the hollow piston 26, which is mounted on the end of the hollow shaft 14. Openings in the piston 26 allow the fluid to pass to the interior of cylinder 24. The usual slight leakage of oil at 38 has no detrimental effect.

A member 40 is secured in fluid tight relation to the interior of the piston 26. In the embodiment shown. the member 40 is secured in position by means of screw threads 42 and locked in position by means of set-screw 44. Gaskets 46 prevent oil from passing from one side of the member 40 to the other through the threaded connection. A member 48 carrying a valve 50 and having an orifice 51 surrounded by a valve seat 52 is threaded into one end of the member 40 and made fluid tight by a gasket 46. A spring 54 urges the valve 50 on to its seat 52. The valve 50, the member 48 and the member 40 thus serve as a means for preventing the passage of oil either to or from the cylinder 24 when the valve 50 is on its seat 52.

The member 40 is provided with a cylindrical bore 56 at the end opposite from the valve 50. A plunger 58 is adapted to reciprocate in the cylinder 56 and is continuously urged toward the valve 50 by a spring 60 of greater strength than the valve spring 54. The plunger 58 is provided with a stem 62 adapted to contact valve 50. The

member 40 is provided with channels 64 leading to a chamber 66. Both the valve 50 and the plunger 58 face this chamber 66. Oil admitted to the hollow shaft 14 passes through channel 64 and enters chamber 66.

If no oil under pressure is supplied to the interior of shaft 14 and if that shaft is connected with a drain, the valve 50 and the plunger 58 will take the position indicated in Figure 2, in which spring 60 being more powerful than spring 54 will force the plunger 58 outward so that member 62 will contact with valve 50 and force this valve to its open position, this motion being limited in the embodiment shown by the contact of the rear portion of the valve 50 with the plug 68. If now, fluid under sufficient pressure is led into the chamber 66, the plunger 58 will be forced to the right to compress spring 60 and if the pressure is sufficiently great valve 50 will be forced off its seat by that pressure and fluid will be admitted through the passage 69 to the interior of the piston 26 and the cylinder 24. If the pressure is of some lesser value, the plunger 58 will be forced to the right, but the pressure will be insufficient to raise valve 50 off of its seat 52 and oil will be prevented from flowing either to or from the interior of cylinder 24.

In order to supply oil at different pressures to the interior of the shaft 14 and to also connect the interior of that shaft with a drain, the valve, indicated generally at 34 in Figure 1 and shown in detail in Figures 3, 4, and 5, is provided. This valve may be mounted at any convenient point and in the modification shown is mounted in the engine casing 16 in such a manner that the engine casing forms the valve housing. This housing is provided with a port connected with the pressure pipe 32. Another port arranged at 90 degrees from the first port is formed by passageway 80 connecting the valve chamber with the interior of the engine crankcase and acting as a drain connection. The casing is provided with a third port 82 arranged 90 degrees from the drain port and approximately 180 degrees from the pressure port. This port 82 connects with the pipe 36 and in turn with the propeller pitch changing mechanism.

A rotatable valve member 70 is mounted to rotate or oscillate adjacent the valve ports and is provided with a passageway 76 extending diametrically therethrough. Another passageway 78 is arranged at right angles to and intersecting passageway 76 thereby forming a T shaped passage in the valve member 70. The valve member 70 is provided with a stem 72 on which is mounted an operating lever 74.

In the position shown in Figure 3, this passageway 76 connects the pressure conduit 32 with the port 82 and the propeller pitch changing mechanism. Moving the operating lever 74 from the position indicated by the dotted lines in Figure 3 to the position indicated by the dot and dash lines in that figure will move the valve member 70 so that passageway 78 will connect with port 82, and passageway 76 will connect with the drain 80 to thereby connect the propeller pitch changing mechanism with the drain.

The hollow extension 84 is formed integral with the valve member 70 and is provided with a pressure relief valve formed by the ball 86, spring 88, and adjusting screw 90. The ball 86 is adapted to close the passage 92, except when the pressure therein is sufficient to raise the ball off its seat. A passage 94 connects the passage 92 with the exterior of the member 70 and a smaller passage 96 connects the passage 92 with the exterior of the member 80 at a point substantially diametrically opposite so that the passages 94 and 96 form a connection from one side of the valve member 70 to the other. The restriction provided in the passageway 96 will prevent fluid from flowing from the source of pressure to the pressure relief valve at a rate greater than that at which it may leave the pressure relief valve through the drain openings and the passage 94. This restriction therefore, functions to prevent the building up of pressure on the propeller side of the relief valve greater than the pressure for which the relief valve 84 is set. If the passage 96 were entirely unrestricted, an excessive pump pressure in the channel 32 might easily cause a flow of fluid to the propeller beyond the capacity of the relief valve to regulate. Furthermore a greatly reduced flow of fluid to the propeller is desirable during the time the propeller is maintained in its fixed pitch condition since the space 66 to be filled by the fluid under these conditions is relatively small, and rapid surges of fluid to the space should be avoided in order to prevent actuation of the valve closing mechanism. The passages 76 and 78 are unrestricted since the space in the propeller cylinder 26 to be filled or emptied by the flow of fluid through these passages is relatively large and it is highly desirable that the cylinder move rapidly in response to a rapid flow of hydraulic fluid whenever the pitch of the propeller is changed.

When the operating lever 74 is moved to a position substantially half way between the two positions indicated in Figure 3, it will be in the position indicated in Figure 4, in which the passages 94 and 96 act to connect the pressure conduit 32 with the port 82 and the interior of the hollow shaft 14. As the pressure relief valve 86 is always in connection with the passages 94 and 96, the interior of the shaft 14 is thus also connected with this pressure relief valve so as to maintain a substantially constant pressure therein.

The operation of this device is as follows: Assuming the engine to be running and the propeller in high pitch position, that is, in the modification shown, with the cylinder moved to its extreme right hand position, the valve 34 is opened by moving it to the position indicated by the dotted lines in Figure 3 to connect the oil pressure line with the interior of shaft 14. This will allow oil under pressure to pass through the shaft 14, passages 64 and into the chamber 66. The oil will then force the plunger 58 to the right as shown in Figure 2 until the stem 98 bottoms on the member 40. The oil in chamber 66 will also force valve 50 off of its seat 52 and thus admit oil under pressure through passages 69 to the interior of the cylinder 24, thus forcing the cylinder outwardly to the left as shown in Figure 1 and turning the propeller to its low pitch position.

In order to again place the propeller in its high pitch position, the valve 34 may be then turned to the position indicated by the dot and dash lines on Figure 3 so as to connect the interior of the shaft 14 with the drain 80. This will allow the oil to drain from chamber 66 so that its pressure will become substantially zero. Spring 60 will then urge the plunger 58 toward the left as shown in Figure 2 causing member 62 to contact with valve 50 and open that valve until it bottoms against the plug 68. Oil in the cylinder 24 is thus allowed to drain back through passages

70 through the interior of the shaft 14 and into the engine crankcase, the blades being turned by the action of centrifugal force.

If it is desired to set the propeller in any intermediate position between its high pitch and low pitch position, the blades are stopped at that position during their change from a lower or from a higher pitch. In order to stop the blades during their pitch changing movements the valve 34 is turned to the intermediate position shown in Figure 4, in which the pressure relief valve is connected into the line between the pressure line 32 and the interior of shaft 14. The pressure relief valve is set to give a pressure in the chamber 66 such that it will force the plunger 58 to the right against the action of spring 60 so as to allow valve 50 to seat by the action of spring 54. The oil pressure is, however, insufficient to force the valve 50 off of its seat against the action of spring 54. The oil contained in cylinder 24 at that time is therefore trapped in that cylinder so that further movement of the pitch changing mechanism is prevented and the propeller is held at the selected pitch.

From the above description, it will be apparent that I have provided a hydraulic controllable pitch propeller with no external oil connections which may be set in any selected pitch position within the limits of its pitch changing range.

Although I have described this device in connection with a particular propeller and specific valve mechanisms, it is to be understood that these descriptions are for the purpose only of disclosing complete and workable apparatus and it will be obvious to others skilled in the art that various modifications in the details of construction may be made without departing from the spirit and scope of the invention defined in the appended claims.

What I claim is:

1. In a propeller, in combination, hydraulic actuated means for changing the pitch of the propeller blades mounted for rotation with the propeller and having an orifice through which oil may be led to and from said means, a spring pressed valve for closing said orifice, a spring pressed plunger adapted to reciprocate adjacent said valve, the plunger spring being of greater strength than said valve spring and adapted in one position to act on said valve to open said valve, means for introducing hydraulic fluid of limited pressure to one side of said plunger to compress said plunger spring and allow said valve to close, and means for introducing fluid under increased pressure to the under side of said valve to open said valve, said fluid introducing means comprising a three way valve adapted in one position to connect said valve and plunger with a source of fluid pressure, and in another position with a drain and in a third position with a pressure relief valve.

2. In combination, a hollow engine shaft, a propeller mounted thereon, hydraulic means for changing the pitch of said propeller operatively connected therewith, a spring pressed valve mounted in said hollow engine shaft for controlling the flow of fluid to and from said hydraulic means, said valve adapted to be opened by fluid pressure in said shaft acting on said valve to introduce fluid from said shaft into said hydraulic means, a spring pressed plunger having a spring stronger than the valve spring adapted to open said valve to allow oil to drain from said hydraulic means into said shaft, said plunger having an area greater than said valve whereby introduction of fluid pressure of a predetermined amount in said shaft will move said plunger away from said valve but will be insufficient to open said valve.

3. In combination, a rotatable shaft, hydraulic mechanism mounted for rotation therewith, a valve for trapping fluid in said mechanism and for controlling the flow of fluid to said hydraulic mechanism from the interior of said shaft and from said hydraulic mechanism to the interior of said shaft mounted for rotation with said shaft, said valve adapted to be opened by fluid pressure in said shaft acting on the exposed area of said valve, a plunger adapted to reciprocate adjacent said valve, a spring of greater strength than the valve spring for urging said plunger against said valve to open said valve, said plunger having a surface subjected to the pressure of fluid in said shaft, of greater area than the exposed area of said valve so that fluid under a predetermined pressure will move said plunger away from said valve but will not open said valve, whereby fluid is trapped in said hydraulic mechanism.

4. Means associated with a rotating member and operated by fluid pressure from a stationary source outside said rotating member to introduce fluid into a mechanism rotating therewith, drain fluid from said mechanism, or hold fluid in said mechanism, comprising, in combination, a valve body mounted to rotate with said rotating member and located between a source of fluid pressure and said mechanism, a valve in said body, a spring for closing said valve, said valve adapted to be opened by fluid pressure from said source acting thereon when that pressure exceeds the pressure in said mechanism by a predetermined amount, a plunger having one side subject to fluid pressure from said source and the other side vented, adapted to reciprocate adjacent said valve, a spring of greater strength than said valve spring for urging said plunger in one direction for opening said valve to allow fluid to drain from said mechanism, said plunger having an area greater than said valve whereby pressure of a predetermined reduced amount will move said plunger in the other direction, but will not open said valve.

5. In combination with a propeller having hydraulically operated mechanism for changing the pitch thereof, means adapted to be controlled by the fluid pressure in a conduit for controlling the flow of that fluid to and from said mechanism connected with said conduit to change the propeller pitch and to hold said fluid in said mechanism to prevent pitch changing movements, comprising, in combination, a valve, a spring for closing said valve, a plunger of greater area than said valve located adjacent said valve, a spring of greater strength than said valve spring for urging said plunger toward said valve and opening said valve against said valve spring pressure, said valve and said plunger adapted to be acted upon simultaneously by the fluid pressure in said conduit and so constructed and arranged that a predetermined pressure will open said valve and also move said plunger away from said valve, a predetermined lower pressure will maintain said plunger away from said valve and permit said valve spring to close said valve and a predetermined still lower pressure or no pressure will permit said plunger to approach said valve and open it.

6. In combination with a three way valve, having a stationary and a movable portion and ports in the stationary portion, a pressure relief valve mounted on the movable portion of said three

way valve, and a conduit in said movable portion registerable in certain positions of said movable portion with the ports in said stationary portion to simultaneously connect two of the ports in said three way valve with said pressure relief valve or to isolate said pressure relief valve.

7. A valve having a stationary portion and a movable portion, ports in the stationary portion, conduits in the movable portion adapted in one position of said movable portion to connect said ports, a pressure relief valve mounted on said movable portion, other conduits in said movable portion not connected with said first mentioned conduits adapted in a different position of said movable portion to simultaneously connect ports in said stationary portion and said pressure relief valve.

8. A valve having a stationary portion and a movable portion and an inlet and an outlet, a pressure relief valve mounted on said movable portion and having an outlet open to drain, a conduit in said movable portion adapted in one position of said movable portion to connect said inlet and said outlet, and a separate conduit in said movable portion comprising a passage operative in a different position of said movable portion to connect said outlet with said relief valve and said relief valve with said inlet.

9. In combination with a hydro-controllable propeller in which the pitch is adjusted by centrifugal force in one direction and by fluid actuated means in the other direction, a rotatable hollow shaft upon which said propeller is mounted, a valve for controlling said fluid actuated means mounted for rotation with said shaft and responsive to the pressure of fluid in said shaft, means for introducing fluid into said shaft from a source outside said shaft and means for controlling the pressure of the fluid in said shaft.

10. In combination with a hydro-controllable propeller in which the pitch is adjusted by centrifugal force in one direction and by fluid actuated means in the other direction, means for controlling the fluid for actuating said fluid actuated means comprising a valve rotatable with said propeller, located in a conduit leading to said propeller and adapted to be opened by fluid pressure of a predetermined amount in said conduit, additional means for opening said valve upon failure of pressure in said conduit, means responsive to a pressure less than said predetermined pressure for rendering said additional means inoperative, a source of fluid pressure, a second valve located in a stationary portion of said conduit between the source of fluid pressure and said first mentioned valve, and a pressure regulating device associated with said second valve, said second valve adapted to connect said first mentioned valve with the source of fluid pressure, a drain, or said pressure regulating device.

11. In combination, a pressure responsive valve for stopping the flow of fluid through a conduit in one direction, a pressure regulating valve, and a three-way manually operably valve having two positions for controlling the direction of flow of fluid through said conduit, and a third position for rendering the fluid in said conduit subject to the regulatory action of said pressure regulating valve to render said pressure responsive valve operative.

12. A control for the hydraulic mechanism of a hydro-controllable propeller comprising, a pressure responsive valve disposed adjacent to said mechanism and operative to lock said mechanism by blocking the flow of hydraulic fluid therefrom, a pressure regulating device and a three-way manually operable valve having two positions for controlling the flow of hydraulic fluid to or from said mechanism and a third position for rendering said fluid subject to the action of said pressure regulating device to render said pressure responsive valve operative to lock said mechanism.

13. In combination with a hydraulically actuated controllable pitch propeller having a hydraulic pitch controlling mechanism rotatable with said propeller, a relatively stationary source of hydraulic pressure, and a hydraulic connection between said source of pressure and said mechanism, means for releasably locking said propeller in a fixed pitch condition at a selected pitch angle comprising, means carried by said rotatable mechanism and responsive to a predetermined pressure of said hydraulic fluid to lock said pitch controlling mechanism, means operative to maintain the pressure of the hydraulic fluid supplied to said mechanism at the pressure to which said locking means responds, and a manually actuatable means for rendering said pressure maintaining means operative or inoperative.

14. In combination with a hydraulically actuated controllable pitch propeller having hydraulic pitch controlling mechanism rotatable with said propeller, a relatively stationary source of hydraulic pressure, and a hydraulic connection between said source of pressure and said mechanism, means for releasably locking said propeller in a fixed pitch condition at a selected pitch angle comprising, a spring pressed valve carried by said rotatable mechanism and operative to block the flow of hydraulic fluid and lock said mechanism, means normally holding said valve open but responsive to a predetermined pressure of said hydraulic fluid to allow said valve to close, relatively stationary means operative to maintain the pressure of the hydraulic fluid at the pressure to which said valve holding means responds, and manually actuatable means for rendering said pressure maintaining means operative or inoperative.

15. In combination with a hydraulically actuated controllable pitch propeller having hydraulic pitch controlling mechanism rotatable with said propeller, a relatively stationary source of hydraulic pressure, and a hydraulic connection between said source of pressure and said mechanism, means for releasably locking said propeller in a fixed pitch condition at a selected pitch angle comprising, a valve carried by said rotatable mechanism and responsive to a predetermined intermediate pressure range to block the flow of hydraulic fluid from said mechanism, and a relatively stationary manually actuatable valve mechanism in the connection between said source of pressure and said mechanism for selectively controlling the flow of hydraulic fluid to and from said mechanism and maintaining the pressure of said fluid within the pressure range to which said fluid locking valve responds.

16. In a valve having a stationary portion and a movable portion and an inlet and an outlet, a pressure relief valve mounted on said movable portion and having an outlet open to drain, a conduit in said movable portion adapted in one position of said movable portion to connect said inlet and said outlet, and a separate conduit in said movable portion adapted in another position of said movable portion to connect said inlet said outlet and said pressure relief valve, said separate conduit comprising, a restricted pas-

sage connecting said inlet with said pressure relief valve, and a substantially unrestricted passage connecting said pressure relief valve with said outlet.

17. In a valve having fluid pressure regulating means for controlling a fluid operated mechanism, a stationary portion having an inlet connected with a source of fluid under pressure and an outlet connected with said mechanism, a pressure relief valve having an outlet open to drain, and a movable portion having a passage adapted in one position of said movable portion with respect to said stationary portion to directly interconnect said inlet and said outlet, and a separate passage adapted in a different position of said movable portion with respect to said stationary portion to connect said inlet, said outlet and said pressure relief valve, said separate passage comprising one portion connecting said inlet with said pressure relief valve and having a degree of restriction at least as great as the degree of restriction of the outlet of said pressure relief valve, and another portion connecting said pressure relief valve with said outlet having a degree of restriction less than the degree of restriction of said one portion.

18. In combination with a hydro-controllable propeller having a low pitch and a high pitch position and in which the pitch is adjusted by fluid actuated mechanism rotatable with the propeller, means for conducting fluid to said mechanism, means for transferring fluid under pressure from a stationary source to said conducting means, pressure responsive hydraulic control means in said conducting means rotatable with said propeller for maintaining said propeller in a fixed pitch condition, and relatively stationary pressure regulating means having a movable portion operable at will during flight for supplying to said pitch fixing means hydraulic fluid at a pressure selected to actuate said pitch fixing means to maintain said propeller in a fixed pitch condition.

19. Control mechanism for a hydro-controllable propeller comprising, mechanism actuated by hydraulic fluid pressure for changing the pitch of said propeller, a fluid conduit connected with said mechanism, and means for trapping hydraulic fluid in said mechanism to restrain said propeller against pitch changes comprising, a valve in said conduit, means providing a force urging said valve to closed position, said valve arranged to be opened by fluid pressure only when the fluid pressure in said conduit exceeds a first predetermined value, means for opening said valve when the fluid pressure in said conduit is below a second predetermined value lower than said first predetermined value, and means responsive to a fluid pressure between said two predetermined values to render said valve opening means inoperative and permit said valve to close.

20. In combination, an hydraulic mechanism, manually operable means for controlling the flow of hydraulic fluid to and from said mechanism, means urged to flow blocking position for blocking the flow of fluid from said mechanism, means, operatively associated with said flow blocking means, for preventing said flow blocking means from blocking said flow of fluid from said mechanism and rendered ineffective by a predetermined fluid pressure, and means associated with said manually operable means selectively operable to maintain the pressure of said hydraulic fluid at the pressure at which said preventing means is rendered ineffective.

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