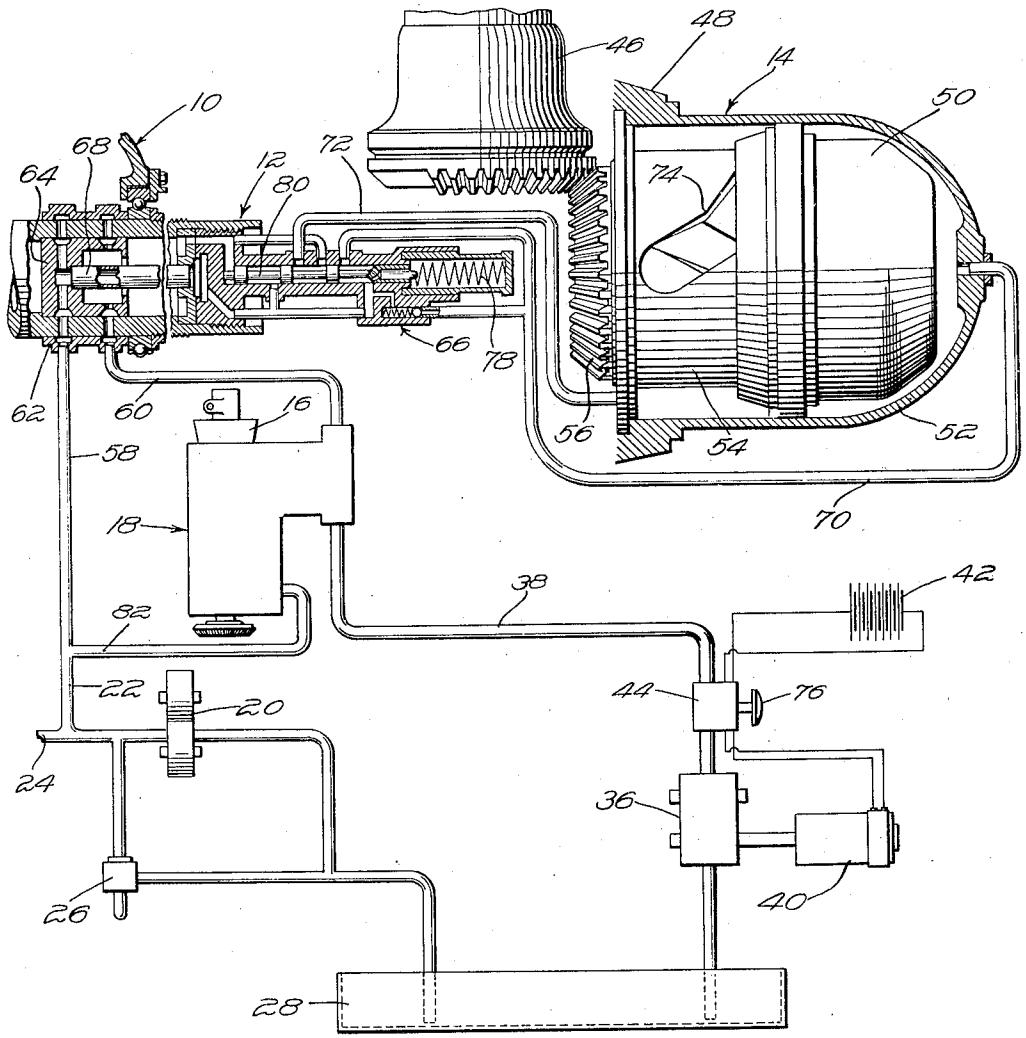
Jan. 4, 1944. M. C. BEEBE, JR 2,338,483

PROPELLER CONTROLS

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Fig. 1.



INVENTOR

Murray C. Beebe Jr.

BY

Harris G. Lucker

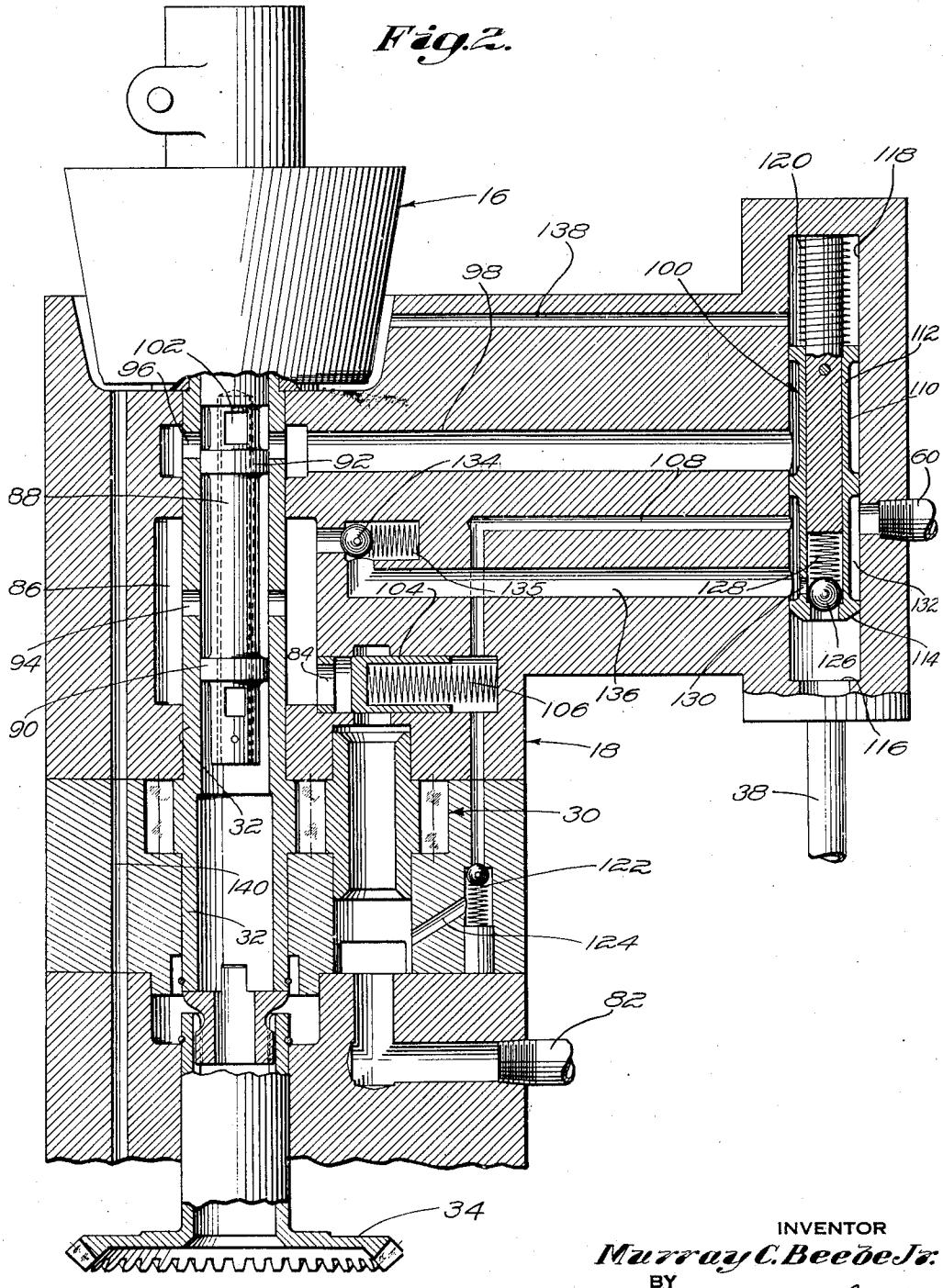
ATTORNEY

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Fig. 2.



INVENTOR

Murray C. Beebe Jr.

BY

Harris G. Luther

ATTORNEY

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PROPELLER CONTROL

Murray C. Beebe, Jr., Glastonbury, Conn., assignor to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

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10 Claims. (Cl. 170—163)

This invention relates to an improved control for a feathering-type controllable-pitch propeller and has particular reference to an improved control for a hydraulically actuated propeller of the character indicated.

An object of the invention resides in the provision in an improved control of the character indicated, having an engine driven pump for supplying hydraulic fluid under pressure to the pitch changing mechanism of the propeller and a motor driven high pressure pump for supplying hydraulic fluid under manual control to the pitch changing mechanism to turn the propeller blades to their feathered condition and return them from the feathered condition to an operative range of pitch angles, of an arrangement for utilizing both pumps to move the propeller blades toward and away from the feathered position.

A further object resides in an improved control for a feathering-type hydro-controllable propeller having an engine driven pump and a motor driven high pressure feathering pump in which the size and weight of the high pressure pump is materially reduced by using the engine driven pump to assist the high pressure pump in turning the propeller blades into and out of the feathered position.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawings, in which like reference numerals are used to designate similar parts throughout, there is illustrated a suitable mechanical arrangement for the purpose of disclosing the invention. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting or restricting the invention as it will be apparent to those skilled in the art that various changes in the illustrated construction may be resorted to without in any way exceeding the scope of the invention.

In the drawings, Fig. 1 is a schematic view of a feathering-type hydro-controllable propeller and a propeller pitch control system, constructed according to the invention, applied thereto, and

Fig. 2 is a detailed sectional view on an enlarged scale of the valve and governor unit of the improved control mechanism.

Referring to the drawings in detail, and particularly to Fig. 1, the numeral 10 generally indicates a propeller driving engine from which projects a propeller drive shaft, generally indicated at 12, carrying a hydro-controllable feathering-type propeller, generally indicated at 14. The propeller pitch is controlled for constant speed operation by an engine driven governor, generally indicated at 16, which governor may be conveniently mounted on a base which constitutes a multiple valve casing, as generally indicated at 18. Hydraulic fluid may be supplied to the propeller pitch changing mechanism through the control unit including the governor 16 and valve case 18 from the engine lubricating oil pump 20 by means of branch conduit or channel 22 leading off of the engine lubricating oil supply line 24. The pressure developed by the pump 20 is regulated by a pressure relief valve 26 draining to an oil reservoir or sump 28 and, as the pressure required for engine lubrication is usually lower than the pressure necessary to provide efficient propeller control, a second engine driven pump is provided for boosting the pressure of the oil supplied to the propeller pitch changing mechanism. Such a pump is illustrated in Fig. 2 and generally indicated at 30, being mounted on and driven by the governor drive shaft 32 which shaft is driven from the engine through a drive including the gear 34.

For feathering and unfeathering the propeller there is provided a high pressure pump 36 the inlet of which is connected with the reservoir or sump 28 and the outlet of which is connected through the channel 38 with the valve mechanism 18 which is in turn connected with the propeller pitch changing mechanism. The pump 36 is driven by a motor 40 energized by a suitable source of power, such as the battery 42, and controlled by a pressure actuated switch 44 which may be of the character illustrated and described in my co-pending United States application Serial No. 304,780, filed November 16, 1939, for Electric feathering control. The propeller 14 may be of the character particularly illustrated and described in United States Patent No. 2,280,714, issued April 21, 1942, to Erle Martin for Feathering propeller control.

In the arrangement illustrated the propeller has a plurality of rotatably mounted blades, one of which is indicated at 46, secured in the hub member 48 which contains a piston 50 movable in a cylinder 52 and cooperating with a cam member 54 which carries a gear 56 meshing with respective gears on the root ends of the propeller blades so that reciprocatory movements of the piston 50 in the cylinder 52 will cause the blades to rotate about their longitudinal axes. Hydraulic fluid is supplied to the pitch changing mechanism through the conduits 58 and 60 which lead through an oil transfer bearing 62 to a plug 64 within the hollow drive shaft 12. From the plug

64 the hydraulic fluid is led to a distributing valve, generally indicated at 66, which valve has two operative positions, namely, a position for constant speed control under regulation of the governor 16, and for feathering the propeller blades, and an unfeathering position, all as particularly illustrated and described in United States Patent No. 2,280,714, referred to above. For constant speed control hydraulic fluid at engine lubricating pressure is led directly from the pump 20 through the conduit 58 to the interior of the plug 64 where a conduit 68 carries it to a portion of the valve 66 connected through the conduit 70 with the space at the pitch reducing end of the piston 50. Hydraulic fluid from the booster pump and governor 16 is led through the conduit 60, plug 64, a portion of the valve 66 and channel 72 to the space at the pitch increasing side of the piston 50.

With this arrangement, during constant speed operation, oil at engine lubricating pressure is continuously applied to the pitch reducing side of the piston 50 and oil at an increased pressure is applied to the pitch increasing side or the space at this side is connected with drain, under the control of the governor 16 to change the propeller pitch in a manner to maintain the speed of the the propeller driving engine substantially constant.

When it is desired to turn the propeller blades to their feathered position the switch 44, or some equivalent device, is actuated to energize the motor 40 driving the high pressure pump 36. When the high pressure pump is in operation hydraulic fluid at an increased pressure is supplied through the line 38 and through a suitable valve and channel 60 to the space at the pitch increasing side of the piston 50. This pressure is sufficient to overcome the increased resistance due to a change in the cam path, as indicated at 74, which acts as a limit stop for the constant speed operation of the propeller, and forces the piston to its extreme pitch increasing position which coincides with a feathered condition of the propeller blade. The switch 44, or equivalent mechanism, is preferably so constructed that when the propeller reaches its feathered condition the increase in pressure of the hydraulic fluid incident to the stopping of the piston 50 in its limiting position will trip the switch and de-energize the motor 40. When it is desired to unfeather the propeller the manual switch control member 76 may be held in to further energize the motor 40 and cause the pump 36 to apply a still higher pressure to the valve 66. When this occurs the spring 78 will collapse permitting the valve plunger 80 to assume a different position in which position the valve will direct the high pressure fluid through the channel 70 to the pitch decreasing side of the piston and will connect the space at the pitch increasing side of the piston with the engine lubricating system so that oil in this space may escape through the pressure relief valve 26.

Since the spaces at the opposite sides of the piston 50 will contain a relatively large amount of fluid when the piston is in the corresponding limiting position and since it is desired that the pitch changing movements of the blades occur in an extremely short time, it has previously been found necessary to provide a feathering pump of large capacity for handling the required amount of fluid in the limited time desired for the feathering and unfeathering operation of the propeller. This has required the provision of a relatively large pump and a heavy comparatively large power motor which not only materially increases the weight of the equipment but also causes a relatively large drain on the battery 42 during the feathering and unfeathering operations. Since, in most cases where feathering is necessary or desired, the engine will continue to rotate until the blades have reached a position very near to their feathered condition and will resume rotation when the blades are moved a relatively small amount out of their feathered position toward the normally operative range of pitch angles, the auxiliary or booster pump 30 will remain in operation for the major part of the feathering and unfeathering operations and it is among the objects of this invention to utilize this operation of the auxiliary engine driven pump to assist in the feathering and unfeathering operations and to thereby reduce the necessary capacity of the motor driven feathering pump.

Referring now to Fig. 2, the branch channel 82, leading from the line 22 to the valve case 18, is connected with the intake of the auxiliary engine driven pump 30 and the outlet of this pump is connected with a pressure chamber 84 which leads into a chamber 86 surrounding a ported portion of the shaft 32 containing the governor operated valve plunger 88. The plunger is provided with spaced pistons 90 and 92 which define the limits of an annular space between the plunger and the shaft 32. The piston 92 cooperates with the port 96 in the shaft 32 in such a manner that when the plunger is raised by the governor, fluid under pressure from the chamber 84 will flow through the port 94, the annular space, the port 96 and the channel 98 and past the valve, generally indicated at 100, to the channel 60 to increase the propeller pitch incident to an increase in engine speed, and when the plunger is lowered by the governor the fluid may flow from the pitch increasing portion of the pitch changing mechanism and through the channel 60, valve 100, channel 98, aperture 102 in the plunger and the hollow interior of the plunger to drain through the hollow drive shaft 32.

The pressure in the chamber 84 is controlled by a relief valve 104 which is urged to its closed position by a relatively light spring 106 and also by the pressure of the fluid in the channel 98 leading to the propeller so that the pressure maintained by the relief valve 104 will always be above the pressure required to operate the propeller by the amount of the force exerted by the spring 106. The fluid pressure is applied to the back of the valve through a channel 108 which is connected with the channel 98 by the elongated groove 110 in the plunger 112 of the valve 100 when the valve is in its constant speed operating position which would be the position in which the lower end 114 of the plunger is in contact with the valve seat 116 at the lower end of the valve bore 118, the valve plunger being normally urged to and retained in this lower or constant speed operating position by the compression spring 120. The maximum pressure permitted by the relief valve 104 is determined by the setting of a safety valve 122 connected with the channel 108 and with the lubricating oil supply channel 82 through a connecting channel 124 and this safety valve may be set to enable the pump 30 to exert a pressure equal to the pressure necessary to return the propeller

from its feathered condition to the operative range of pitch angles.

When the feathering pump **36** is operated to change the propeller from the constant speed operation described above to a feathered condition, high pressure fluid flowing through the channel **38** will enter the lower end of the bore **118** and act against the ball **126** closing the hollow lower end of the plunger **112**. As the ball **126** is held against its seat in the lower end of the plunger by a spring **128** the pressure fluid will raise the plunger **112** to the position shown in Fig. 2 and unseat the ball **126** and fluid will flow past this ball valve and through the port **130** in the plunger and into the lower annular groove **132**. From this groove the high pressure fluid will flow through the channel **60** to the pressure increasing side of the pitch changing mechanism and will flow through the channel **108** to increase the fluid pressure backing up the relief valve **104** so that the output pressure of the pump **30** will be raised to equal the output pressure of the pump **36**. As the pressure of the output of the pump **30** increases the check valve **134** will be opened permitting the output of the pump **30** to flow through the channel **136** to the annular groove **132** and through channel **60** to the pitch increasing side of the propeller thus adding the output of the pump **30** to the output of the pump **36**. The spring **106** is sufficiently stronger than the spring **135** of the check valve **134** that the check valve will be opened by a pressure difference less than the pressure difference required to open the relief valve **104**. As the channel **98** is blocked off by the valve plunger **110** when in its raised position none of the fluid forced through the pump **30** can vent through the drain aperture **102** in the governor valve plunger **88**. It is also to be noted that when the valve is in its lowermost position the channel **136** is blocked off so that the output of the pump **30** cannot be applied directly to the propeller but must first pass through the governor actuated valve and the outlet of the pump **30** cannot be connected with drain through the channels **136** and **98** when the plunger **88** is in its lower position. Also the ball **126** will close the connection between the channel **136** and the high pressure pump.

The space above the valve plunger **112** may be vented through the channel **138** which channel may lead to the interior of the governor case which is in turn vented to drain through the channel **140** so that fluid cannot be trapped in the space above the plunger and thereby interfere with the operation of the feathering control valve.

From the above description it will be seen that as long as the engine driven pump **30** is operative during the propeller feathering or unfeathering operations, the output of this pump is utilized to assist the feathering pump **36** in moving the propeller blades towards or away from their feathered position. The pump **30** will cease operation when the propeller blades are near their feathered position and the pump **36** must then be depended upon to complete the feathering or to initiate the unfeathering operation but as the amount of movement between the fully feathered position and the cessation or resumption of engine operation is very small a relatively small capacity feathering pump can perform this portion of the operation without undue loss of time or efficiency.

While a particular mechanical arrangement has been hereinabove described and illustrated in the accompanying drawings for the purpose of disclosing the invention, it is to be understood that the invention is not limited to the particular arrangement so described and illustrated, but that such changes in the size, shape and arrangements of the various parts may be resorted to as come within the scope of the sub-joined claims.

Having now described the invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows:

1. In combination with a feathering-type hydro-controllable propeller and a propeller driving engine, an engine driven fluid pump having its outlet pressure controlled by means responsive to the fluid pressure required to change the pitch of said propeller, an independently driven high pressure pump for feathering and unfeathering said propeller, a connection between said engine driven pump and a pressure line leading to said propeller, a connection between said high pressure pump and said pressure line, and valves operatively associated with and blocking said connections and effective when subjected to the output of said high pressure pump to render said engine driven pump capable of delivering fluid at a pressure as great as that of said high pressure pump by applying the pressure of said high pressure pump to said means, and to unblock both said connections to connect both of said pumps with said propeller.

2. In a propeller pitch control mechanism including an engine driven pump, a governor controlling the application of the output of said pump to the propeller for constant speed operation, and an independently driven high pressure pump for feathering and unfeathering the propeller, valves disposed between said pumps and said propeller operative to block off the high pressure pump from the propeller when the high pressure pump is not operating and connect said engine driven pump through said governor with said propeller, and operative when said high pressure pump is operating to block off said governor from said propeller and connect the outlets of both pumps directly with said propeller, and means operatively associated with said engine driven pump and rendered effective by said high pressure pump to raise the outlet pressure of said engine driven pump to the pressure developed by said high pressure pump.

3. In combination with a feathering type hydro-controllable propeller and a propeller driving engine, an engine driven fluid pump, a governor controlled valve, an independently driven high pressure pump for feathering and unfeathering said propeller, a connection between said engine driven pump and said governor controlled valve, a connection between said governor controlled valve and said propeller, a connection between said high pressure pump and said propeller, pressure actuated valves in the connections between said governor controlled valve and said propeller and between said high pressure pump and said propeller, a connection between said pressure actuated valves and said engine driven pump, and a one way valve in said last mentioned connection effective to prevent a flow of hydraulic fluid under pressure from said high pressure pump through said engine driven pump, said pressure actuated valves acting when subjected to the output of said high pressure pump to block the connection between said governor controlled valve and said propeller and connect both of said pumps directly with said propeller.

4. In a propeller pitch control mechanism including an engine driven pump, a governor controlling the application of the output of said pump to the propeller for constant speed operation, and an independently driven high pressure pump for feathering and unfeathering the propeller, valves disposed between said pumps and said propeller operative to block off the high pressure pump from the propeller when the high pressure pump is not operating and connect said engine driven pump through said governor with said propeller and operative when said high pressure pump is operating to block off said governor from said propeller, and connect the outlets of both pumps directly with said propeller, means operatively associated with said engine driven pump and rendered effective by said high pressure pump to increase the outlet pressure of said engine driven pump, and a check valve between said engine driven pump and said propeller to prevent a flow of fluid from said high pressure pump through said engine driven pump when operation of said engine driven pump is discontinued.

5. Propeller pitch control mechanism for a fluid controlled propeller comprising an engine driven pump, a relief valve for said pump having one side connected with the fluid supply line for said propeller to maintain the pump discharge pressure a fixed amount above the fluid supply line pressure, mechanism normally controlling the application to said propeller of the fluid discharged by said pump, another pump, a second valve having ports connected with said mechanism, said propeller, said engine driven pump discharge, and said other pump discharge, said second valve normally connecting said mechanism with said propeller and positively blocking said propeller from said pump discharges and movable by the pressure of fluid from said other pump to disconnect said mechanism from said propeller and remove the positive blocking between the discharge of both pumps and said propeller and a check valve at the outlet side of each pump to prevent a discharge of hydraulic fluid from one pump through the other pump.

6. In combination with a hydro-controllable propeller, a pump, a fluid supply line for said propeller, means to maintain the pump discharge pressure above the fluid supply line pressure, mechanism normally controlling the application to said propeller supply line of the fluid discharged by said pump, another source of fluid pressure, and a pressure actuated valve connected with said mechanism, said propeller fluid supply line, said pump discharge and said other source of pressure, connecting said mechanism and said propeller fluid supply line and acting as an obstruction between said fluid supply line and said pump discharge and movable by the pressure of fluid from said other source of pressure to disconnect said mechanism from said propeller fluid supply line and remove said obstruction between the pump discharge and said fluid supply line.

7. Propeller pitch control mechanism for a fluid controlled propeller comprising an engine driven pump, a fluid supply line from said pump to said propeller, means to maintain the pump discharge pressure above the fluid supply line pressure, mechanism normally controlling the application to said propeller of the fluid discharged by said pump, another pump, and a pressure actuated valve connected with said mechanism, said propeller, said engine driven pump discharge, and said other pump discharge and movable in one direction by resilient means to connect said mechanism with said propeller and block said propeller from both said pump discharges and movable in the other direction by the pressure of fluid from said other pump to disconnect said mechanism from said propeller and render said valve ineffective to block said propeller from the discharge of both pumps with said propeller.

8. In combination with a feathering-type hydro-controllable propeller, an engine driven pump for supplying hydraulic fluid to said propeller, a connection between said pump and said propeller, a governor controlled valve in said connection, a relief valve in said connection, means for applying the pressure in said connection to the relief valve to maintain the output of said pump at a pressure at least as high as the fluid pressure required to operate the pitch changing mechanism of said propeller, a high pressure pump for supplying fluid at a pressure sufficient to feather and unfeather said propeller, and a connection between said high pressure pump and said propeller, a pressure actuated valve in the connection between said high pressure pump and said propeller intercepting the connection between said engine pump and said propeller, and a connection between said engine driven pump and said pressure actuated valve bypassing said governor controlled valve, said pressure actuated valve being operative when subjected to the pressure exerted by said high pressure pump to block the connection from said engine driven pump to said propeller through said governor controlled valve and connect both of said pumps directly with said propeller.

9. The arrangement as set forth in claim 8 in which said pressure actuated valve comprises a plunger reciprocable in a cylinder and having a pair of spaced pistons for controlling said connections between said engine driven pump and said propeller, a valve face at one end for closing the connection between said high pressure pump and said propeller, and a spring resiliently urging said plunger in a direction to close said last mentioned connection.

10. In combination with a feathering type hydro-controllable propeller and a propeller driving engine, an engine driven fluid pump having its outlet pressure regulated by the fluid pressure requirements of said propeller, a governor controlled valve, an independently driven high pressure pump for feathering and unfeathering said propeller, a connection between said engine driven pump and said governor controlled valve, a connection between said governor controlled valve and said propeller, a connection between said high pressure pump and said propeller, a check valve in said last mentioned connection, a pressure actuated valve in the connections between said governor controlled valve and said propeller and between said high pressure pump and said propeller, and a connection between said pressure actuated valve and said engine driven pump, said pressure actuated valve being movable by the pressure of said high pressure pump to block the connection between said governor controlled valve and said propeller and connect both of said pumps directly with said propeller.

MURRAY C. BEEBE, JR.