July 11, 1944. C. KELLER 2,353,566

VARIABLE PITCH PROPELLER

Filed July 28, 1942 4 Sheets-Sheet 1

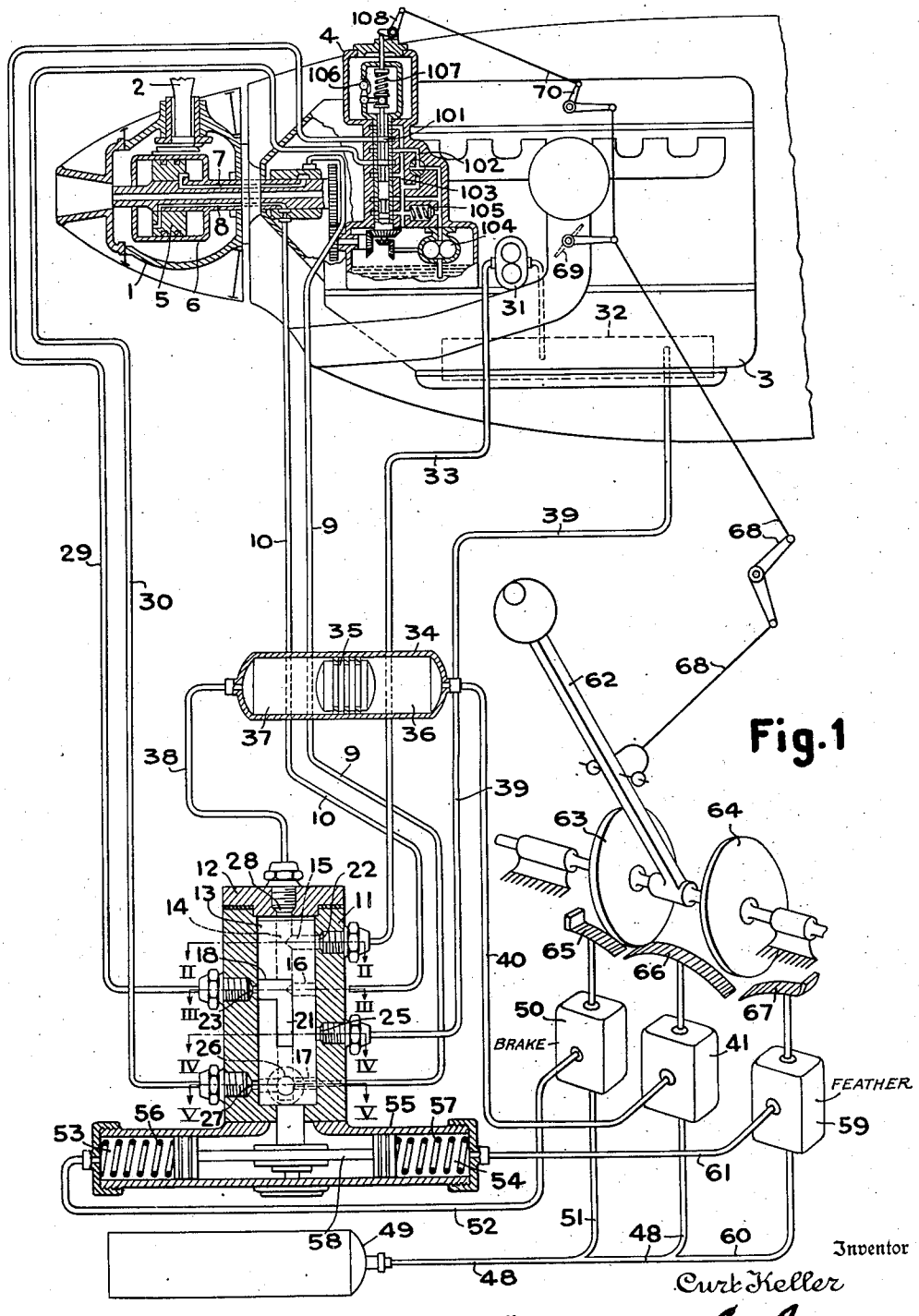

Fig.1

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July 11, 1944. C. KELLER 2,353,566

VARIABLE PITCH PROPELLER

Filed July 28, 1942 4 Sheets-Sheet 2

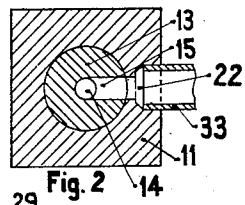

Fig. 2

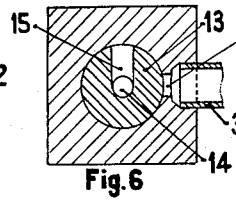

Fig. 6

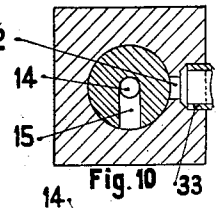

Fig. 10

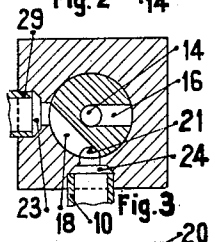

Fig. 3

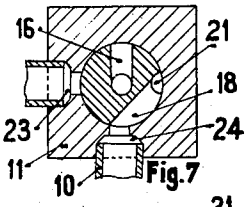

Fig. 7

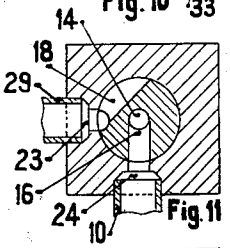

Fig. 11

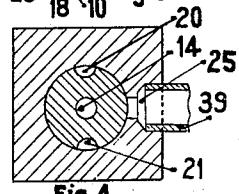

Fig. 4

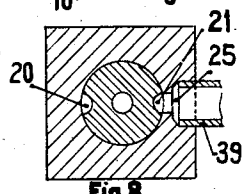

Fig. 8

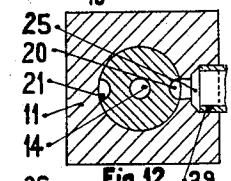

Fig. 12

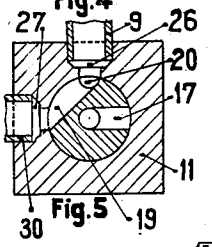

Fig. 5

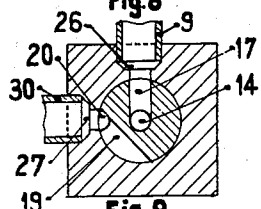

Fig. 9

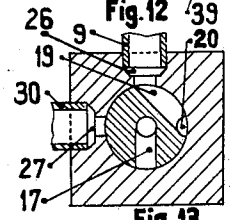

Fig. 13

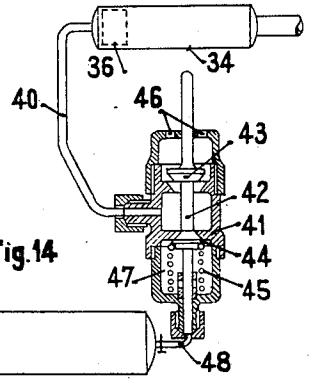

Fig. 14

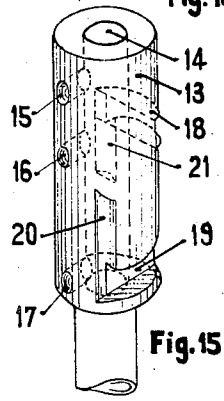

Fig. 15

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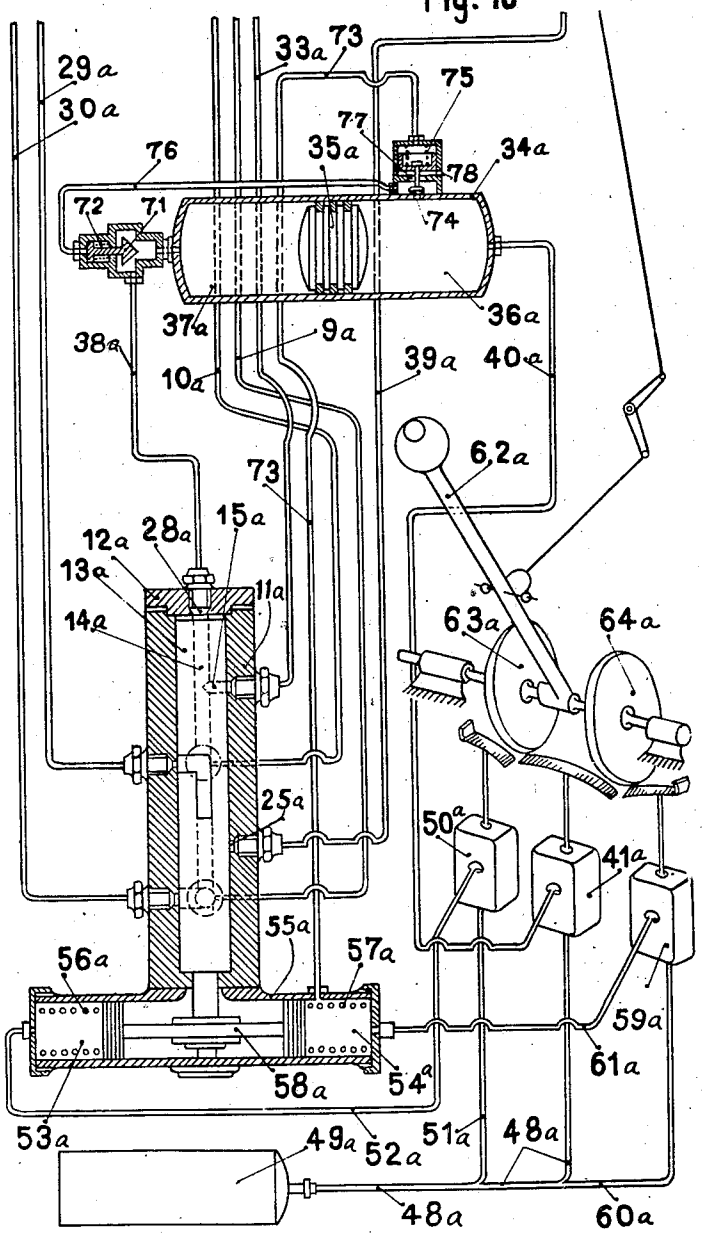
July 11, 1944. C. KELLER 2,353,566

VARIABLE PITCH PROPELLER

Filed July 28, 1942 4 Sheets-Sheet 3

Fig. 16



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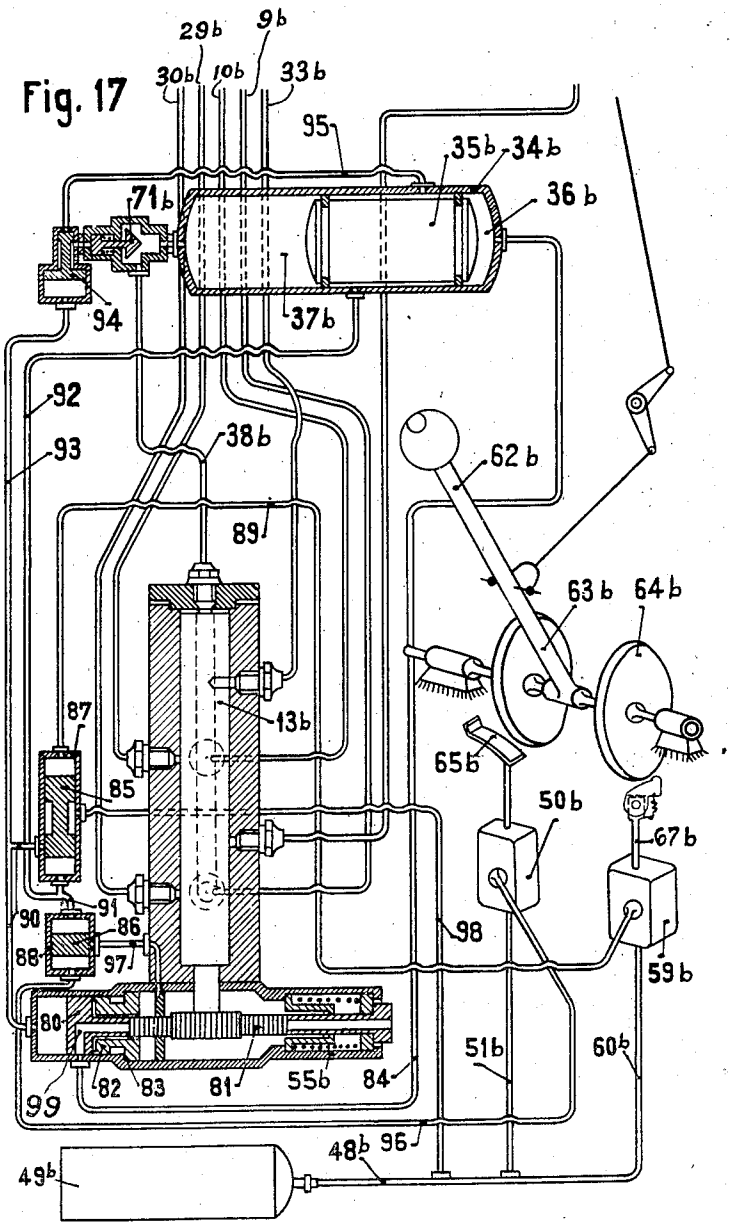
July 11, 1944. C. KELLER 2,353,566

VARIABLE PITCH PROPELLER

Filed July 28, 1942 4 Sheets-Sheet 4

Fig. 17



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Patented July 11, 1944 2,353,566

UNITED STATES PATENT OFFICE

2,353,566

VARIABLE-PITCH PROPELLER

Curt Keller, Zurich, Switzerland, assignor to Escher Wyss Maschinenfabriken Aktiengesellschaft, Zurich, Switzerland, a corporation of Switzerland

Application July 28, 1942, Serial No. 452,623
In Switzerland July 21, 1941

5 Claims. (Cl. 170—135.6)

This invention relates to a hydraulically actuated device for the blade adjustment of variable-pitch propellers, especially for aircraft, of the type in which the adjustment of the blades beyond a normal, predetermined pitch range into extreme end positions becomes possible only after an increase of the hydraulic pressure has been brought about. Such extreme end positions are the feathered position and the braking position. These extreme positions involve, however, always a certain amount of risk when flying if means are not provided to ensure that these positions can only be reached with sufficient rapidity or after a deliberate action on the part of the pilot. If, for example, the arbitrary displacement of the blades into an extreme end position is not effected with sufficient rapidity, it might occur that the number of revolutions of the driving engine increases to an inadmissible extent when the blades are moved through certain ranges of the angles of incidence.

The object of this invention is to provide an adjusting device of the kind first referred to which, whilst being easy to manipulate and to service, ensures with certainty the speedy attainment of any one of the desired extreme end positions. To meet these requirements, the hydraulic control device according to the present invention comprises a storage vessel divided into two chambers by a member displaceable therein, and further a member operable at will by the pilot and permitting one of said chambers being arbitrarily connected either to the pressure side of a pressure oil pump for the engine driving the propeller or, for the purpose of effecting a quick adjustment of the blades into an extreme end position, to the blade adjusting mechanism proper, the other one of said chambers being connected, also by means of said member operable at will by the pilot, in the first case to the atmosphere and in the second case to an auxiliary source of pressure in which a higher pressure prevails than in the first mentioned chamber. In a preferred embodiment of the invention the hydraulic control device for adjusting the blades comprises a change-over member operable in an indirect manner by the pilot and allowing in one of its positions, which corresponds to an adjustment of the blades within the normal pitch range, not only a working connection between a speed governor and the blade adjusting mechanism proper, but also replenishing of one of said storage chambers by the pressure oil pump, said change-over member effecting in two further positions on the one hand a connection between said storage chamber and the blade adjusting mechanism proper, and on the other hand between this mechanism and the outlet for the pressure oil.

The accompanying drawings show, partly in a simplified mode of representation, and by way of example, constructional embodiments of the subject matter of the invention. In these drawings,

Fig. 1 shows partly in a side view and partly in section a part of a variable-pitch aircraft propeller, its driving engine, and the hydraulic control device for adjusting the propeller blades.

Figs. 2 to 5 are sections on a larger scale taken along the lines II—II, III—III, IV—IV and V—V of Fig. 1, showing the plug and casing of a change-over valve, the parts being in the normal position in which the governor is in control of the propeller pitch.

Figs. 6 to 9 show similar sections as Figs. 2 to 5, the plug of the change-over valve being illustrated in another position, in which the valve functions to cause setting of the propeller blades in braking position.

Figs. 10 to 13 likewise show similar sections as Figs. 2 to 5, the plug of the valve being illustrated in a third position, in which the valve functions to cause setting of the propeller blades in feathering position.

Fig. 14 shows an axial longitudinal section through a control valve on a larger scale and also a front view of the parts connected to this valve.

Fig. 15 shows the plug of the change-over valve in a perspective mode of representation.

Fig. 16 shows a part of a hydraulic blade-adjusting device in which the position of a shut-off valve controlling the passage of pressure medium from one chamber of a storage vessel divided into two chambers by a displaceable member to the blade-adjusting mechanism proper, is dependent on the momentary position of said displaceable member, and

Fig. 17 shows a modification of a detail.

Like reference numerals refer to like parts throughout the drawings.

In Fig. 1 the numeral 1 denotes an aircraft propeller comprising a hydraulic control device for adjusting its blades 2. The numeral 3 denotes the engine driving the propeller 1 and 4 is a speed governor of a design similar to that shown in the application Ser. No. 334,443. This governor 4 controls automatically the adjustment of the propeller blades 2 within a normal-predetermined pitch range into such positions as to cause the driving engine 3, and therefore also the propeller 1, to run at an almost constant speed. The speed governor 4 controls, in a manner

known per se, the supply and discharge of pressure medium, preferably oil under pressure, to and from the blade adjusting mechanism proper. This mechanism comprises, amongst other elements, a stationary piston 5, on which a double-acting control cylinder 6, is axially movable, any longitudinal movement of the latter being converted into pitch-adjusting motion of the propeller blades 2. The numerals 7 and 8 denote longitudinal passages through which pressure medium can be supplied to one of the cylindrical chambers, on opposite sides of the piston 5, whilst pressure medium is discharged from the other chamber. The passage 7 is connected to a pipe 9 and passage 8 to a pipe 10.

The governor 4 is a simplified embodiment of the type shown in application Ser. No. 334,443 and simply for example is shown as conforming in its principal details to the governor shown in Patent 2,274,334 Feb. 24, 1942, and well known in the art.

A balanced piston valve 101 has a minute positive lap on two controlled ports which lead respectively to the passages 29 and 30, as shown. The valve is shiftable from its port-closing mid-position (shown in Fig. 1), to connect either passage 29 or 30 to supply passage 102, and the other simultaneously to one of the branches of release passage 103.

Pressure fluid is supplied to passage 102 by a gear pump 104, and a loaded relief valve 105 is interposed between passages 102 and 103 to limit the pressure developed. The lower end of valve 101 functions to unload pump 104 except when pressure fluid is to be delivered to one of the passages 29 or 30 but this detail is familiar and not involved in the invention.

The position of valve 101 is controlled by a flyball governor 106 which rotates with the valve seat and is loaded by a speeder spring 107. The spring 107 may be variably stressed by bell-crank 108 which is shifted in consonance with engine throttle 69 to which it is connected by linkage 70.

The pump 104 and governor member 106 are driven from the engine 3 by a gear train shown schematically in Fig. 1. In this figure the governor is shown on an exaggerated scale and in diagrammatic section.

When the governor is connected to the blade-adjusting motor 6 it functions to vary propeller pitch in such a way as to absorb the engine output efficiently. A times the governor is disconnected from motor 6 to permit other means to assume control, as will now be explained.

In Figs. 2 to 13 the numeral 11 denotes the casing of a change-over valve which has a cover 12, as also a distributing member designed as plug 13 (Fig. 15). In this plug 13 a channel 14 is provided extending practically over its whole length and from which three transverse bores 15, 16 and 17 branch off. On the circumference of the plug 13 are provided two transverse milled slots 18 and 19, as also two longitudinal slots 20 and 21. The casing 11 has a number of bores 22, 23, 24, 25, 26 and 27, and in the cover 12 is provided a bore 28 (Fig. 1).

The above mentioned pipe 9 is further connected to the bore 26 of casing 11 and pipe 10 to the casing bore 24. To the bore 23 of the casing 11 a pipe 29 is connected and to the casing bore 27 a pipe 30; these pipes 29 and 30 are connected at the other end to the ports described as controlled by valve 101 of speed governor 4. The numeral 31 denotes a pump which supplies oil under pressure for lubricating the driving engine 3; it sucks oil from a tank 32 and forces it through a pipe 33 leading to the bore 22 of casing 11, as well as to the lubricating system of the engine. Such systems include some pressure limiting means such as a relief valve.

34 is a storage vessel divided into two chambers 36 and 37 by a member 35 displaceable therein. A pipe 38 connects the chamber 37 to bore 28 in cover 12 of the change-over valve. To the bore 25 of casing 11 a pipe 39 is connected which discharges into the oil collecting tank 32. Chamber 36 of the storage vessel 34 is in its turn connected through a pipe 40 to a control valve 41 which is shown in Fig. 14 in section on a larger scale. This valve 41 has a spindle 42 and two cones 43 and 44; as soon as the cone 44 is forced by a spring 45 against its seat, cone 43 gives free the connection between chamber 36 and the atmosphere via pipe 40 and openings 46 in the valve casing. A lower space 47 of the valve 41 is connected through a pipe 48 to an auxiliary source of pressure, which in the embodiment illustrated has the form of a compressed air container 49. The numeral 50 denotes a second control valve, designed in the same manner as control valve 41, and which is connected on the one hand through a pipe 51 to pipe 48 and through a pipe 52 to the chamber 53 of an auxiliary cylinder 55. In the latter a double piston 58 is arranged in a manner permitting of its being displaced but which is usually maintained in a mid-position by two springs 56 and 57; when this double piston 58 is displaced, turning of the plug 13 of the change-over valve in one sense or the other is brought about by means which are not shown in detail. The numeral 59 denotes a third control valve which is likewise designed in the same manner as the control valve 41 and is connected on the one hand through a pipe 60 to pipe 48 and on the other hand through a pipe 61 to the chamber 54 of cylinder 55. Operation of the spindles of the control valves 41, 50 and 59 is effected by a member designed as a hand lever 62 which must be moved deliberately by the pilot; on being displaced in the direction of the axis of its fulcrum this member 62 acts through rollers 63, 64 either on cams 65, 66 or 66, 67 which are disposed at the upper end of the spindles of the valves 50, 41 and 59 respectively. Hand lever 62 is also operatively connected by a system 68 of rods and levers to a throttle valve 69 which permits the output of the driving engine 4 being regulated. The hand lever 62 is further operatively connected to the adjusting device of the speed governor 4 by means of said system 68 and a further system 70 of rods and levers.

The manner of operation of the described hydraulic control device for adjusting the blades 2 of the propeller 1 is as follows: When flying under normal conditions, in which case the blades 2 are adjusted by speed governor 4 only within their normal pitch-range, the hand lever 62 may be swung on its fulcrum to adjust the throttle and governor, while in a position in which neither of the rollers 63, 64 acts on any of the cams 65, 66, 67. Consequently, the valve 41 interrupts the connection between pipes 48 and 40, since the valve cone 44 (Fig. 14) now rests on its seat. The valve cone 43 is on the other hand raised from its seat so that chamber 36 of the storage vessel 34 is connected to the atmosphere through pipe 40 and the openings 46 in the valve casing 41. At this time the spindles of valves 50 and 59

assume such a position that chambers 53 and 54 of the auxiliary cylinder 55 are connected to the atmosphere, so that the piston 58 in cylinder 55 takes up its mid-position, whilst the flow through pipes 51 and 60 is obstructed by these valves 50 and 59.

The plug 13 of the change-over valve hereby assumes such a position that the connections shown in Figs. 2 to 5 are effected. The pipe 9 leading to the blade adjusting mechanism proper is connected through bore 26 (Fig. 5) in the casing 11, transverse milled slot 19 and casing bore 27 to the pipe 30 of governor 4. At the same time the pipe 10 leading to the blade adjusting mechanism proper is connected through casing bore 24 (Fig. 3), transverse milled slot 18 and casing bore 23 to the pipe 29 of governor 4. The described connections enable governor 4 to adjust the blades 2 within their normal pitch-range in dependency on the speed of the driving engine 3. Furthermore, pipe 33 of the pressure oil circuit is connected through casing bore (Fig. 2), transverse bore 15, channel 14, plug 13 and bore 28 in cover 12 to the piping 38, which in its turn is connected to chamber 37 of the storage vessel 34. Since at the same time the second chamber 36 of the storage vessel 34 is connected to the atmosphere through pipe 40 and valve 41, it is possible for the pump 31 to deliver oil under pressure to chamber 37 of the storage vessel 34 until the piston 35 has been forced entirely to the right (Fig. 1).

If now at any time the blades 2 have, for example, to be brought into a braking position, the hand lever 62 must be so adjusted as to cause roller 63 to act on cam 65 and at the same time roller 64 to act on cam 66. This results in such a displacement of the spindle of valve 50 that auxiliary pressure medium from container 49 can flow through pipings 48, 51 and 52 into the chamber 53 of the auxiliary cylinder 55. Consequently the piston 58 is moved to the right (with reference to Fig. 1), whereby at the same time plug 13 of the change-over valve is brought into such a position that the connections shown in Figs. 6 to 9 are established. Since apart from valve 50 the valve 41 has also been simultaneously influenced, auxiliary pressure medium can now flow from container 49 through pipes 48 and 40 also into chamber 36 to the right of piston 35. As provision is made to ensure that the pressure of the auxiliary pressure medium supplied from the container 49 is considerably higher than the maximum pressure prevailing at any time in storage chamber 37, the piston 35 is rapidly moved to the left which is possible in consequence of the momentary position of plug 13. In the position assumed by plug 13 at this time, the following connections are established: The chamber 37 of the storage vessel 34 is connected through pipe 38, cover bore 28, plug channel 14, plug bore 17 (Fig. 9) and casing bore 26 to the pipe 9 which leads to the blade adjusting mechanism proper. The second pipe 10 which is connected to this mechanism communicates through casing bore 24 (Fig. 7), transverse milled slot 18, longitudinal milled slot 21 and casing bore 25 (Fig. 8) with the pipe 39, so that oil under pressure can flow out of the mechanism 5, 6 into the tank 32. The oil which is forced under high pressure out of the storage chamber 37 can now speedily bring about an adjustment of the blades 2 into their braking position. The transverse milled slots 18 and 19 are at this moment in such a position that the flow of pressure oil through pipes 29 and 30 to and from the governor 4 is interrupted, so that the latter cannot influence the adjusting mechanism. As may be noted from Fig. 6, plug 13 also obstructs the passage of pressure oil through pipe 33 which is connected to the oil pump 31.

When the blades 2 have to be brought into a high-pitch position, lever 62 is adjusted in such a manner that the rollers 63 and 64 act on the cams 66 and 67 respectively, which brings about such an adjustment of the spindles of valves 41 and 59 that on the one hand auxiliary pressure medium from container 49 can pass through pipes 48 and 40 into the storage chamber 36 on the right of piston 35, whilst on the other hand auxiliary pressure medium also passes through pipes 48, 60 and 61 into the chamber 54 of auxiliary cylinder 55, so that the piston 58 movable inside the latter is forced to the left. This brings about such a displacement of the plug 13 that the connections shown in Figs. 10–13 are effected. Oil under pressure can now pass from storage chamber 37 through pipe 38, cover bore 28, plug channel 14, plug bore 16 (Fig. 11) and casing bore 24 into pipe 10 which brings about a rapid adjustment of the blades 2 into a high-pitch position; at the same time oil can flow from the pitch-adjusting mechanism through pipe 9, casing bore 26 (Fig. 13), transverse milled slot 19, longitudinal milled slot 20 and casing bore 25 (Fig. 12) into the discharge pipe 39. In this case also the flow through pipes 29 and 30 connected to the speed governor 4 is interrupted by the plug 13 (see Figs. 11 and 12 as also Fig. 13). Furthermore the bore 15 of plug 13 is now in a position (Fig. 10) in which no pressure oil can flow through the pipe 33 connected to the oil pump 31.

The size of the chambers 36, 37 and the quantities of oil which have to be supplied by the storage chamber 37, in order to bring about an adjustment of the propeller blades 2 into an extreme end position, are so chosen that at least two adjustments of the blades into such extreme end positions can be carried out without intermediate recharging of chamber 37.

Fig. 16 shows an adjusting device wherein means are provided which, on an adjustment of the propeller blades into a given operating position, for example the braking position, having been completed, prevent the escape of pressure medium from the chamber in which the pressure medium employed for adjusting the propeller blades is stored. Without such means the danger exists that after the blades have been adjusted into a given operating position, pressure medium might continually escape from the storage chamber as a result of leakage losses in the blade adjusting mechanism proper, so that sufficient pressure medium might no longer be available for subsequently moving the blades into another position, for example the high-pitch position, a circumstance that might involve grave dangers. In Fig. 16, parts identical with those in Figs. 1–15 are given the same reference numerals with the letter *a*. In the embodiment illustrated in Fig. 16 the position of a shut-off member controlling the passing of pressure medium from one of the storage chambers to the blade adjusting mechanism proper is therefore made dependent in such a manner on the momentary position of the piston which subdivides

the storage vessel that on a given position of said piston having been past, displacement of said shut-off member into its closing position is automatically brought about, since the pressure medium of higher pressure from the other storage chamber can then act on this shut-off member. Hereby the latter influence can at any time be arbitrarily interrupted by a manipulation on the part of the pilot.

In this Fig. 16 the numeral **38a** denotes the pipe connecting chamber **37a** of storage vessel **34a** to the bore **28a** in cover **12a** of the change-over valve. A shut-off valve **71** urged open by a spring **72** is fitted in said pipe **38a**. Furthermore, the numeral **55a** designates in this case the auxiliary cylinder in which the double piston **58a**, usually kept in a mid-position by the springs **56a**, **57a**, is arranged in a displaceable manner and which, each time it is displaced, causes a turning movement of the plug **13a** of the change-over valve in one sense or the other. To the space **54a** of the auxiliary cylinder **55a** is further connected a pipe **73** leading to chamber **36a** of storage vessel **34a**; this connection is controlled by a releasing valve **74** which a spring **75** usually tends to maintain in the closed position. In this latter position a pipe **76** connecting the interior of the casings of valves **71**, **74** to the chamber on the left of valve **71** is then connected to the atmosphere through a bore **77** and a further bore **78** in the casing of valve **74**.

In the following the manner of operation of those parts of the embodiment shown in Fig. 16 which differ from the parts of the example illustrated in Figs. 1 to 15 are particularly described. The piston **35a** of the storage vessel **34a** is shown in a position which it assumes whilst chamber **37a** of this storage vessel is being charged with pressure medium. The latter flows to this chamber **37a** from pipe **33a** through channel **14a** in the plug **11a** and bore **28a** in the cover **12a**. The air which is forced out on the right of piston **35a** during charging of the chamber **37a** flows through pipe **40a** and valve **41a** into the atmosphere. The liquid under pressure flowing to chamber **37a** through pipe **38a** keeps the shut-off valve **71** open, whilst spring **75** holds the valve **74** in its closed position. When the storage vessel **34a** has been filled with pressure liquid the piston **35a** assumes its extreme right hand end position.

When the blades of the propeller have to be adjusted from the normal, predetermined pitch range into the braking position, the hand lever **62a** has to be adjusted by the pilot in such a manner that valves **41a** and **50a** are opened. As soon as this has been effected, auxliary pressure medium flows out of the container **49a** through pipes **48a** and **40a** into storage chamber **36a**, so that the piston **35a** is moved to the left, since measures have been taken to ensure that the pressure of the auxiliary pressure medium exceeds that of the liquid stored in chamber **37a**. The liquid now forced out of chamber **37a** passes through the open valve **71** into pipe **38a** and causes hereupon the adjustment of the propeller blades into their braking position. The parts are so dimensioned that when the blades have reached the braking position the piston **35a** will have overtravelled the port leading to valve **74**. This allows the auxiliary pressure medium contained in chamber **36a** to act on the releasing valve **74**, so that the latter is opened. This involves a closing of the shut-off valve **71**, since auxiliary pressure medium can now flow from the chamber **36a** through pipe **76** to the left hand side of valve **71** which is consequently forced against its seat. As a result, further emptying of storage chamber **37a** is prevented until such time as an adjustment of the propeller blades into the high-pitch position becomes necessary. When this has to be effected, the hand lever **62a** is adjusted in such a manner that valves **41a** and **59a** are opened. A connection between the source of auxiliary pressure **49a** and storage chamber **36a** is then again established. However, also auxiliary pressure meduim from container **49a** can now flow through valve **59a** into chamber **54a** of the auxiliary cylinder **55a** and from this chamber through pipe **73** to the upper end of valve **74**, so that the latter is again closed. This now involves an opening of the valve **71** in that, when valve **74** is closed, pipe **76** is connected to the atmosphere through openings **77** and **78**, so that the pressure medium in storage chamber **37a** gains the preponderance. As a result of this the shut-off valve **71** is opened and an adjustment of the blades into the high-pitch position now becomes possible. An adjustment of the propeller blades into this position is ensured by the fact that from the moment the blades reached their braking position, any escape of pressure medium from the storage chamber **37a** was prevented by the shut-off valve **71**, so that sufficient pressure medium for moving the blades into the high-pitch position is always available in this chamber **37a**.

Since the blades must always first be brought from the high-pitch position back into their normal, predetermined pitch range, an opportunity of refilling the storage chamber **37a** with pressure medium presents itself before a renewed adjustment of the blades into their braking position has to take place.

Finally Fig. 17 illustrates an embodiment which permits the valve **41a** hereinbefore described being dispensed with, so that the manipulation of the whole device is consequently simplified.

In Fig. 17 parts identical with those in Fig. 16 are given the same reference numeral with the letter *b*. The piston **80** moving inside the auxiliary cylinder **55b** and which serves for turning the plug **13b** of the change-over valve is in this case provided on one side with an extension **81** taking the form of a toothed rack. A bore **99** leading to the atmosphere extends through these parts **80**, **81**. Furthermore, within cylinder **55b** is provided an auxiliary piston **82** which surrounds the extension **81** with ample clearance and is carried along by piston **80** when the latter moves to the right, whilst the movement of this auxiliary piston **82** to the left is limited by a stop **83** on the casing **55b**. In a given position of piston **80** a pipe **84** effects a connection between the bore **99** and the chamber **36b** of storage vessel **34b**. The numeral **85** denotes a quick-closing valve and **86** an oscillating valve, the first of which moves freely in a casing **87** and the second in a casing **88**. The space above the quick-closing valve **85** is connected by a pipe **89** to the valve **59b**. To the casing **87** a pipe **90** is further connected which leads to the space on the left of piston **80**. From this pipe **90** a pipe **93** branches off which leads to the space below an auxiliary piston **94**; the latter controls the discharge from a pipe **95** which is connected to the storage vessel **34b**. The space below the quick-closing valve **85** is connected through a pipe **91** to the space above the oscillating valve **86**. From this pipe **91** a further pipe **92** branches off which is connected to the storage vessel **34b** at a point to the left of the one where pipe **95** is jointed to this vessel. The space below oscillating valve **86** is connected by

a pipe 96 to the valve 50b whilst a pipe 97 effects a connection between the space to the right of auxiliary piston 82 and the interior of casing 88 when the auxiliary piston 82 and the oscillating valve 86 are in a given position. Also in this embodiment of the invention a shut-off valve 71b controls the discharge of pressure oil from the storage chamber 37b into the pipe 38b leading to the plug 13b of the change-over valve.

The device illustrated in Fig. 17 operates as follows: The various parts are shown in the positions which they assume under normal flying conditions. Accordingly, the hand lever 62b is adjusted in such a manner that neither roller 63b nor roller 64b can act on cam 65b or 67b, and the storage chamber 36b is connected through pipe 84 and bore 99 to the atmosphere, whilst the storage chamber 37b is filled with pressure oil, since the pressure oil flowing through pipe 38b to this chamber 37b keeps the shut-off valve 71b open.

When the blades of the propeller have to be adjusted from the normal pitch range into the braking position, the hand lever 62b is operated by the pilot in such a manner that the valve 50b is opened. As soon as this has taken place, auxiliary pressure medium from the container 49b can pass through pipes 48b and 51b, as also through the valve 50b and pipe 96 to the space below the oscillating valve 86, so that the latter is raised and as a result hereof, the supply to pipe 97 given free. Auxiliary pressure medium now also flows into the space on the right of auxiliary piston 82, whereby this pressure medium can, as a result of the clearance between auxiliary piston 82 and piston extension 81, also act on the right end surface of piston 80, which is now displaced to the left, thus permitting auxiliary pressure medium to pass through the above mentioned clearance between parts 82 and 81 into pipe 84 which is connected to the storage chamber 36b. The auxiliary pressure medium flowing into this chamber causes a rapid displacement of piston 35b to the left, so that the pressure oil stored in chamber 37b is likewise quickly forced into pipe 38b and thence to the change-over valve. The plug 13b of the latter is at this time in a position in which it admits a flow of pressure oil into the blade adjusting mechanism proper which now effects, in the manner previously described, an adjustment of the blades into their braking position.

The braking position of the blades is reached as soon as the right hand ring of piston 35b uncovers pipe 95. When this has taken place auxiliary pressure medium passes from chamber 36b through pipe 95 to the space above the auxiliary piston 94 which is therefore moved downwards, so that also a supply of auxiliary pressure medium to the left hand side of the shut-off valve 71b is given free. As a consequence, the latter is moved into its closing position in which it prevents any further discharge of pressure medium from the storage chamber 37b.

When the braking position has to be left, it is essential that the hand lever 62b be first moved in such a manner that valve 59b is opened, whereby the quick-closing valve 85 is then also operated. As soon as the latter allows a flow through pipe 98, the remaining movements are automatically started, i. e. the auxiliary pressure medium flowing through pipes 48b, 98 and now also through pipe 90 flows on the one hand to a space below the auxiliary piston 94 which consequently closes the pressure pipe 95 so that shut-off valve 71b is opened and pressure medium can pass to the change-over valve. On the other hand auxiliary pressure medium also passes through pipe 90 into the chamber to the left of piston 80, so that the latter is forced into its extreme right position. Thus the chamber to the left of piston 80 is connected by pipe 84 to the storage chamber 36b, so that the piston 35b is moved into its extreme left position, i. e. into the position in which it allows a flow through pipe 92. When the latter is the case, auxiliary pressure medium also passes into the space below the quick-closing valve 85, thus causing an interruption of the connection between pipes 98 and 90, as also into the space above the oscillating valve 86. The latter is consequently moved into its lower position, so that auxiliary pressure medium can now also pass to the chamber on the right of the pistons 82 and 80. Due to a differential action these pistons are hereupon brought into the position shown in Fig. 17, in which chamber 36b is again connected through pipe 84 and bore 99 to the atmosphere, whilst the plug 13b reassumes its initial position. At the same time air is vented through pipe 92 from the space below the quick-closing valve 85 and thereby through pipe 90 also from the chamber on the left of piston 80 and further through pipe 91 from the space above the oscillating valve 86, so that the whole system is no longer subjected to pressure above atmospheric and its parts are returned into the positions which they have to assume whilst the propeller blades are adjusted within the normal pitch range. The storage chamber 37b is then again recharged with pressure oil.

The shell 34 and piston 35 of Fig. 1, and their analogs in Figs. 16 and 17 serve as a liquid accumulator (the space 37) with pressure operated means (piston 35 and space 34) for rapidly expelling the accumulated liquid. Air bottle 49 serves as a secondary source of pressure fluid under a pressure higher than that of the liquid delivered by pump 31. These parts assure adjustment of the propeller blades to their extreme positions and with the utmost expedition.

What is claimed is:

1. The combination of a propeller having blades which are adjustable to vary pitch; means for supplying liquid under pressure; a hydraulic motor connected to adjust said blades through their entire range; a governor responsive to propeller speed and capable of controlling the supply and exhaust of pressure liquid to and from said hydraulic motor to adjust the propeller blades within a limited intermediate pitch range; a liquid accumulator; pressure operated means for rapidly expelling liquid from said accumulator; a secondary source of pressure fluid under pressure higher than that of said liquid under pressure; a change-over valve having a normal position in which it connects the governor in controlling relation with the hydraulic motor and charges the accumulator with liquid under pressure, and at least one functional position in which it disconnects the hydraulic motor from the governor and connects the motor with the accumulator; and means operable to shift the change-over valve from its normal to said functional position and subject said expelling means to pressure from said secondary source.

2. The combination of a propeller having blades which are adjustable to vary pitch; means for supplying liquid under pressure; a double-acting hydrauluic motor connected to adjust

said blades through their entire range, said motor having opposed working spaces; a governor responsive to propeller speed and capable of controlling the supply and exhaust of pressure liquid to and from said working spaces to adjust the propeller blades within a limited intermediate pitch range; a liquid accumulator; pressure operated means for rapidly expelling liquid from said accumulator; a secondary source of pressure fluid under pressure higher than that of the liquid under pressure; a change-over valve having a normal position in which it connects the governor in controlling relation with the hydraulic motor and charges the accumulator with liquid, and two distinct functional positions in which respectively it disconnects the hydraulic motor from the governor, and connects different ones of the two working spaces of the motor with the accumulator while connecting the opposite working space to discharge; and means operable to shift the change-over valve from normal to selected functional positions and concurrently to subject said expelling means to pressure from said secondary source.

3. The combination of an engine; an energy input controller for said engine; an adjustable pitch propeller driven by said engine; an expansible chamber motor for actuating the pitch-adjusting mechanism of said propeller; a governor responsive to propeller speed for controlling said motor through a normal range of pitch adjustment; a high pressure accumulator device for actuating said motor for extreme ranges of pitch adjustment; a change-over valve for interchanging said governor and accumulator in functional relationship to said motor; and a single controller having two distinct ranges of motion in one of which it adjusts the energy input controller without affecting the change-over valve, and in the other of which it causes the change-over valve to shift while maintaining the adjustment of the energy input controller.

4. The combination of a propeller having blades which are adjustable to vary pitch; means for supplying liquid under pressure; a double-acting hydraulic motor connected to adjust said blades through their entire range, said motor having opposed working spaces; a governor responsive to propeller speed and capable of controlling the supply and exhaust of pressure liquid to and from said working spaces to adjust the propeller blades within a limited intermediate pitch range; a liquid accumulator; pressure operated means for rapidly expelling liquid from said accumulator; a secondary source of pressure fluid under pressure higher than that of the liquid under pressure; a change-over valve having a normal position in which it connects the governor in controlling relation with the hydraulic motor and charges the accumulator with liquid, and two distinct functional positions in which respectively it disconnects the hydraulic motor from the governor, and connects different ones of the two working spaces of the motor with the accumulator while connecting the opposite working space to discharge; means operable to shift the change-over valve from normal to selected functional positions and concurrently to subject said expelling means to pressure from said secondary source; normally inactive limiting valve means capable of being rendered active upon displacement of a given quantity of liquid from the accumulator to inhibit further discharge of liquid therefrom; means effective upon shifting of the change-over valve to one of said functional positions to condition said limiting valve to operate; and means rendered effective upon shifting of the change-over valve to the other of said functional positions to inhibit operation of said limiting valve and to restore it to inactive condition if it then be operating.

5. The combination defined in claim 4 in which the accumulator is a cylinder, the pressure operated expelling means is a piston working therein, the limiting valve means includes a pressure motor which closes the valve against yielding resistance, and the accumulator piston upon motion through a given range exposes a port through which high pressure fluid is supplied to the valve motor.

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