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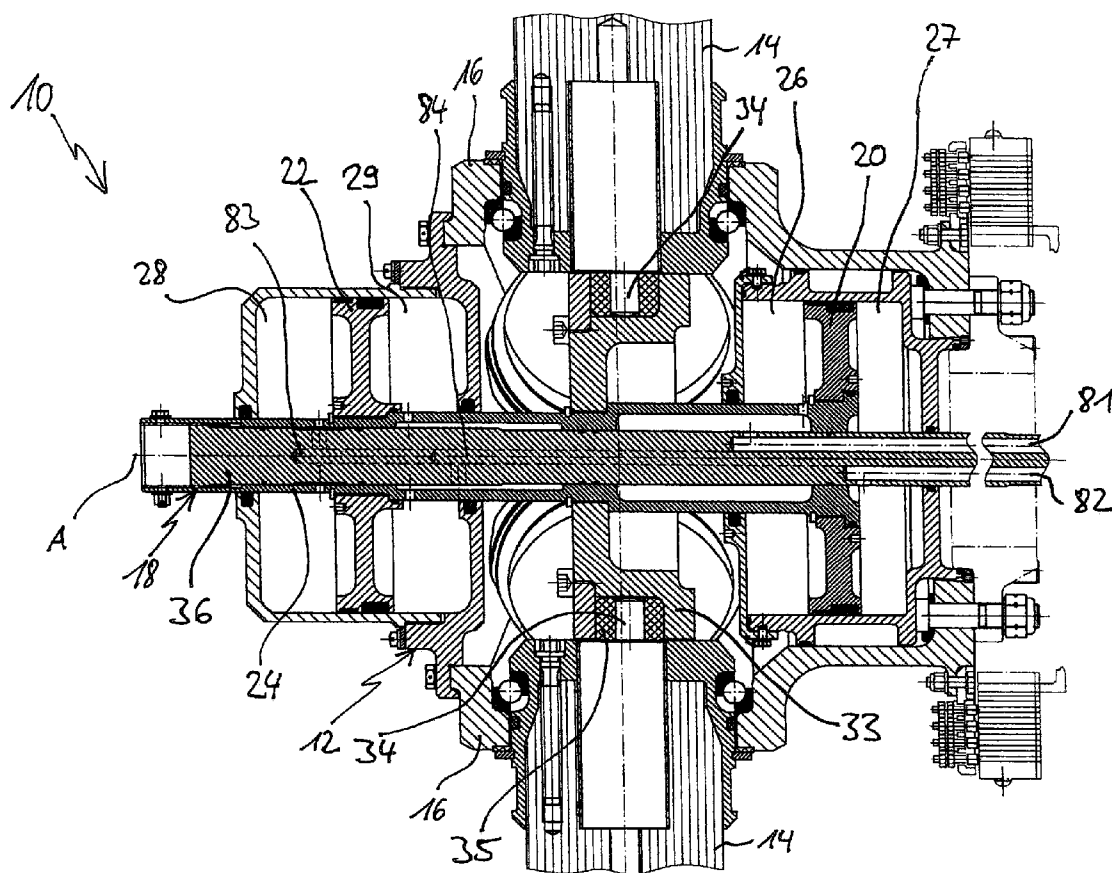
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Mühlbauer(10) **Pub. No.: US 2012/0099991 A1**(43) **Pub. Date: Apr. 26, 2012**(54) **HYDRAULIC VARIABLE PITCH PROPELLER****Publication Classification**(76) Inventor: **Gerd R. Mühlbauer**, Mitterfels
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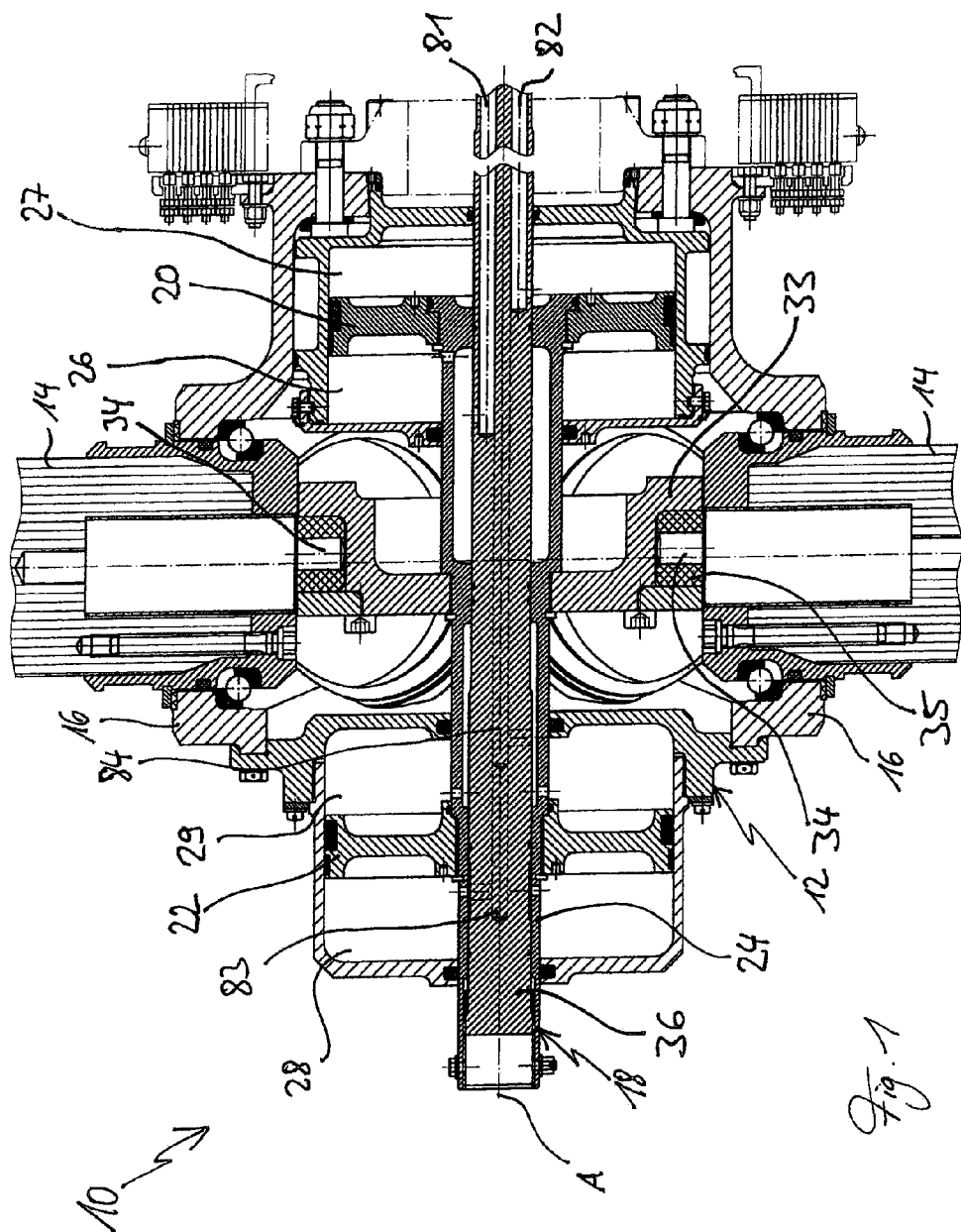
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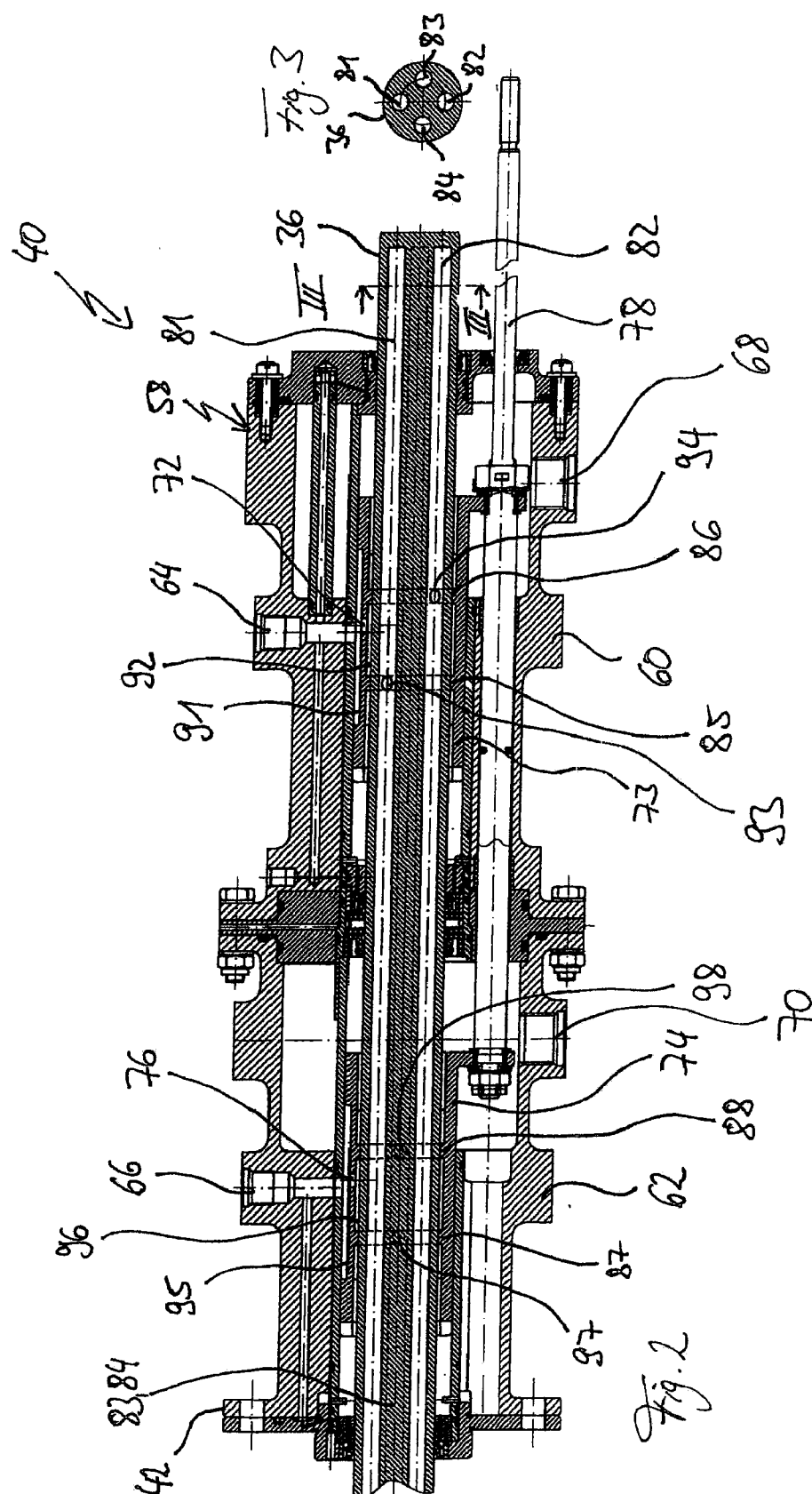
(52) **U.S. Cl.** **416/157 R**(57) **ABSTRACT**(21) Appl. No.: **13/276,582**(22) Filed: **Oct. 19, 2011**(30) **Foreign Application Priority Data**

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Proposed is a redundant hydraulic variable pitch propeller for an air, land or water craft, comprising at least two propeller blades (14) mounted in the region of a propeller hub (12) with variable pitch control by means of a hydraulically powered piston assembly (18). In accordance with the invention the piston assembly (18) comprises two mechanically interconnected servo pistons (20, 22) each assigned to an independent hydraulic circuit. Each of the servo pistons is engineered as a double-acting piston.







HYDRAULIC VARIABLE PITCH PROPELLER

[0001] The invention relates to a redundant hydraulic variable pitch propeller for an air, land or water craft having the features as set forth in the preamble of claim 1.

[0002] Such a variable pitch propeller is known in practice which comprises a hydraulic means including a piston assembly by means of which the pitch of the propeller blades can be varied.

[0003] A variety of devices and methods are known in principle for varying the pitch of propeller blades, it usually being the case that these involve hydraulic systems by means of which the pitch can be automatically and continuously varied as to an assigned engine power, propeller RPM and flight speed. These known systems feature a servo piston, meaning that no pitch variation is possible when the hydraulic system fails. In order to prevent hazardous overspeeding, means are included to block the pitch change of the propeller blades. Known, in particular, is to install counterweights in the blade shank region of each propeller blade which, however, adds undesired weight.

[0004] Further, to prevent hazardous overspeeds with a failure of the hydraulics the usual pitch control systems comprise what is called a pitch lock device, which locks the blade angle in the position which existed at the point in time of the pressure loss.

[0005] The invention is based on the object of defining a hydraulic variable pitch propeller featuring a hydraulic system which ensures high operational safety of the propeller without the aforementioned safeguards.

[0006] This object is achieved in accordance with the invention by a hydraulic variable pitch propeller having the features as set forth in claim 1.

[0007] Consequently in accordance with the invention, a redundant hydraulic variable pitch propeller system for an air, land or water craft is proposed, comprising at least two propeller blades mounted in the region of a propeller hub for variable pitch control by means of a hydraulically powered piston assembly. The piston assembly comprises two mechanically interconnected servo pistons, each assigned to an independent hydraulic circuit. Each servo piston is engineered as a double-acting piston. Thus, the servo pistons are defined axially, i.e. in the direction of varying the pitch on both sides by a hydraulic pressure space so that varying the pitch is defined by the difference in pressure between the two pressure spaces.

[0008] With a variable pitch propeller in accordance with the invention it is now possible to control a piston assembly even when one of the two independent hydraulic circuits malfunctions, so that varying the pitch of the propeller blades is still assured. This assures high safety of operation of a variable pitch propeller system without having counterweights on the blade shanks or providing a pitch lock as aforementioned. Both servo pistons are so dimensioned that in case of one hydraulic circuit malfunctions, varying the pitch of the propeller blades is possible solely by the other hydraulic circuit. Varying the pitch of the propeller blades is now achieved in both directions by application of a corresponding hydraulic pressure to the servo pistons. As a function of the wanted pitch variation a corresponding pressure differential is set in the two pressure spaces defining a servo piston, resulting in a positioning of the servo piston in thus varying the pitch of the propeller blades.

[0009] In one preferred embodiment of the hydraulic variable pitch propeller in accordance with the invention, the two hydraulic circuits comprise a common valve assembly by means of which the two servo pistons are activated synchronized with a wanted servo pressure. This valve assembly comprises, for example, two control spools operated by a common actuator and which are positioned by the hydraulic or servo pressure in which the two pistons of the propeller assembly are arranged in the region of the propeller hub, for changing the blade pitch.

[0010] In one special embodiment of the valve, in accordance with the invention, the valve assembly and the servo pistons are interconnected by a double-walled control tube, comprising four control passageways, each of which is assigned a pressure space, two each of which define one of the servo pistons.

[0011] The control tube can cooperate with the two control spools of the valve assembly, each assigned to one of the hydraulic circuits.

[0012] The valve assembly comprises in particular two independent hydraulic chambers supplied by two independent pressure sources and hydraulically connected via the control tube to pressure spaces, each assigned to one of the servo pistons, the control tube also mechanically connecting the valve assembly to the pistons of the piston assembly.

[0013] The valve or control assembly may also comprise two control spools, each actuated independently of the other and each assigned to one of the servo pistons in supplying hydraulic fluid to the two servo pistons, each independently of the other, to maintain pitch control even when one of the hydraulic circuits fails.

[0014] The control assembly is mounted especially on a gearbox of an engine for the rotational drive of the propeller. Expediently the control tube passes through the gearbox into the propeller hub, making the hydraulic connections between the control assembly and the pressure spaces for the servo pistons.

[0015] The pressurized hydraulic fluid used for the two hydraulic circuits can be supplied statically with a constant pressure by means of a pump or dynamically by means of a propeller governor.

[0016] Further advantages and advantageous aspects of the invention are shown from the description, the drawing and the claims.

[0017] An example of a variable pitch propeller in accordance with the invention will now be described with reference to its simplified illustration in the drawing in which:

[0018] FIG. 1 is a longitudinal section through a propeller hub;

[0019] FIG. 2 is a longitudinal section through a control assembly for varying the pitch of propeller blades; and

[0020] FIG. 3 is a cross-section through a control tube of the variable pitch propeller.

[0021] Referring now to FIG. 1 there is illustrated a hydraulic variable pitch propeller 10 comprising a propeller hub 12 and at least two propeller blades 14 with assigned bearings 16 and of variable pitch.

[0022] Housed in the propeller hub 12 is a piston assembly 18 comprising two servo pistons 20 and 22 mechanically interconnected by a connecting tube 24 sited in the axis A of the propeller hub 12. The servo piston 20 borders on one side a first pressure space 26 and on the other side a second pressure space 28. The two pressure spaces 26 and 27 are assigned a first hydraulic circuit. The servo piston 22 borders

on one side a third pressure space 28 and on the other side a fourth pressure space 29. The pressure spaces 28 and 29 are assigned a second hydraulic circuit. The servo pistons 20 and 22 are thus each engineered double-acting defined on both sides axially by a pressure space.

[0023] Connected to the piston assembly 18 is a bifurcated part 33 engaging a slipper 35 via each of the positioners 34 varying the pitch of the propeller blades 14 on actuation of the piston assembly 18.

[0024] Located in the connecting tube 24 is a control tube 36 fixedly secured to the connecting tube 24, as well as hydraulically connecting the pressure spaces 26, 27, 28 and 29 via control passageways 81, 82, 83 and 84 to a control or valve assembly 40 as shown in FIG. 2. The control assembly 40 is mounted with a flange 42 to the rear end of a gearbox (not shown) of the engine (likewise not shown). The control tube 36 consequently passes through the gearbox.

[0025] The control assembly 40 through which the control tube 36 passes comprises a two-part valve body 58, a first valve body member 60 being assigned the first hydraulic circuit and a second valve body member 62 fluidly communicating with the first valve body member 60 being assigned the second hydraulic circuit. Each of the two valve body members 60 and 62 is provided with a servo pressure port 64 and 66 respectively fluidly communicating with a pressure source assigned to the corresponding hydraulic circuit which may be configured as a pump or also as a propeller governor. In addition, the two valve body members 60 and 62 each comprise a return port 68 and 70 respectively.

[0026] Arranged in the valve body member 60 is a first control spool 73 which is slidingly located at the control tube 36 via two sealing lips 85 and 86 each axially spaced away from the other. The control spool 73 comprises an outer annular space 91 in fluid communication with the servo pressure port 64 and connected by a spool port 72 to an inner annular space 92 defined axially by the two sealing lips 85 and 86 and radially inside by the control tube 36. Depending on the position of the control spool 73 the control passageway 81 can be fluidly communicated via a control tube port 93 or the control passageway 82 via a control tube port 94 to the inner annular space 92 for applying hydraulic pressure as available at the servo pressure port 64 to the first pressure space 26 or second pressure space 27. In the middle position as shown in FIG. 2 the control tube ports 93 and 94 are made to coincide with the sealing lips 85 and 86 of the control spool 73, this position corresponding to the zero setting of the propeller blades 14.

[0027] Arranged in the second valve body member 62, corresponding to the first valve body member 60, is a second control spool 74 which is slidingly located at the control tube 36 via two sealing lips 87 and 88 and serves to control the hydraulic pressure applied to the pressure spaces 28 and 29. The control spool 74 comprises an outer annular space 95 in fluid communication with the servo pressure port 66 and connected by a spool port 76 to an inner annular space 96 defined axially by the two sealing lips 87 and 88 and radially inside by the control tube 36. Depending on the position of the control spool 74 the inner annular space 96 can be fluidly communicated either via a control tube port 97 to the control passageway 83 for applying hydraulic pressure as available at

the servo pressure port 66 to the pressure space 28 or via a control tube port 98 to the control passageway 84 in applying hydraulic pressure as available at the pressure space 29. In the position as shown in FIG. 2 the two control tube ports 97 and 98 are made to coincide with the sealing lips 87 and 88, this position likewise corresponding to the zero setting of the propeller blades 14. The axial spacing between control tube ports 97 and 98 corresponds to the axial spacing between the sealing lips 87 and 88. Correspondingly the axial spacing between control tube ports 93 and 94 assigned to the control spool 73 corresponds to the axial spacing of the sealing lips 85 and 86 of the the control spool 73.

[0028] The control spools 73 and 74 are connected by a common actuating rod 78 extending in the axial direction of the control assembly 40 and slidingly positioned by means of a suitable actuator axially to position the control spools 73 and 74. It is this positioning of the control spools 73 and 74 by means of the actuating rod 78 that the hydraulic pressure communicated via the control passageways 81, 82, 83 and 84 to the servo pistons 20 and 22 is varied so that depending on the difference in pressure in the pressure spaces 26, 27, 28 and 29 the piston assembly 18 is positioned axially in varying the pitch of the propeller blades 14.

1. A hydraulic variable pitch propeller for an air, land or water craft, comprising:

at least two propeller blades, each of said propeller blades having a variable pitch;

a propeller hub including a hydraulically powered piston assembly controlling the pitch of the propeller blades, said assembly having two mechanically interconnected double-acting servo pistons, each of said servo pistons being coupled to an independent hydraulic circuit.

2. The hydraulic variable pitch propeller as set forth in claim 1, in which said two hydraulic circuits comprise a common valve assembly by means of which the two servo pistons are movable in synchronism with a desired servo pressure.

3. The hydraulic variable pitch propeller as set forth in claim 2, in which said valve assembly and servo pistons are interconnected by a control tube comprising four control passageways each of which is assigned a pressure space two each of which define one of the two servo pistons.

4. The hydraulic variable pitch propeller as set forth in claim 3, in which said control tube cooperates with two control spools of the valve assembly, each assigned to one of the hydraulic circuits.

5. The hydraulic variable pitch propeller as set forth in claim 4, in which said control spools are connected to a common actuating rod.

6. The hydraulic variable pitch propeller as set forth in claim 1, in which said valve assembly includes two independent hydraulic chambers supplied by two pressure sources and hydraulically connected via the control tube to the pressure spaces each coupled to one of the servo pistons.

7. The hydraulic variable pitch propeller as set forth in claim 1, in which said two servo pistons are dimensioned so that varying the pitch of the propeller blades is assured under all operating conditions with just one of the servo pistons moved by the hydraulic fluid.

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