# United States Patent [19]

**Almqvist**

[11] **3,711,221**

[45] **Jan. 16, 1973**


## [54] DEVICE FOR VARYING THE PITCH OF PROPELLER BLADES


[75] Inventor: **Bo Karl Loritz Almqvist**, Hagersten, Sweden

[73] Assignee: **Aktiebolaget Scania Vabis**, Sodertalje, Switzerland



[22] Filed: **June 8, 1970**

[21] Appl. No.: **44,522**

[30] **Foreign Application Priority Data**

June 6, 1969 Sweden ..... 8105/69

[52] **U.S. Cl.** ..... **416/157**

[51] **Int. Cl.** ..... **B63h 3/08**

[58] **Field of Search** ..... 416/157, 4 G, 16 Z, 154; 91/376, 378, 318, 32, 33



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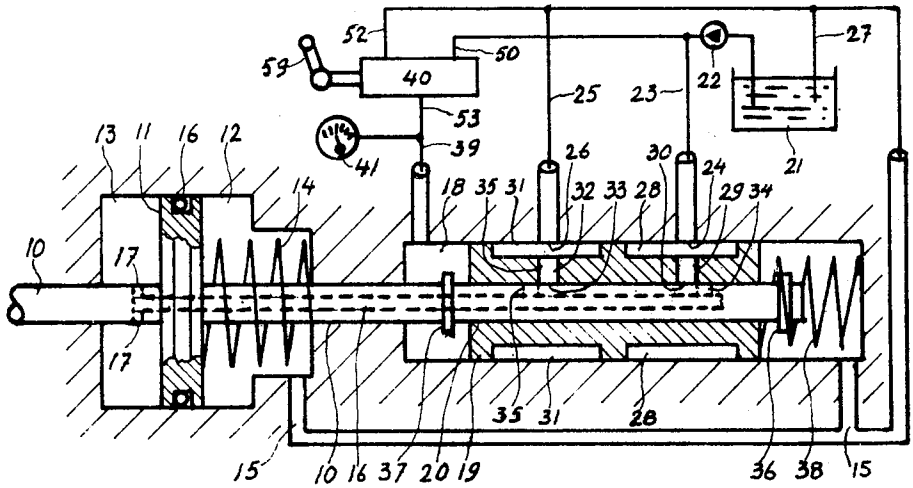
*Primary Examiner*—Everette A. Powell, Jr.
*Attorney*—Silverman and Cass



[57] **ABSTRACT**

A device for varying the pitch of the propeller blades in an engine driven boat. A hydraulic motor having a work cylinder with a working piston imparts movements to the propeller blades and to an auxiliary cylinder through a mechanical transmission member. The auxiliary cylinder includes a follow-up slide which cooperates with the transmission member. The transmission member has inlet and outlet openings and a channel to conduct a pressure medium to and from the working cylinder. The follow-up slide has inlet and outlet openings which cooperate with the openings in the transmission member so that control of the position of the working piston is determined by the position of the follow-up slide.


**6 Claims, 4 Drawing Figures**



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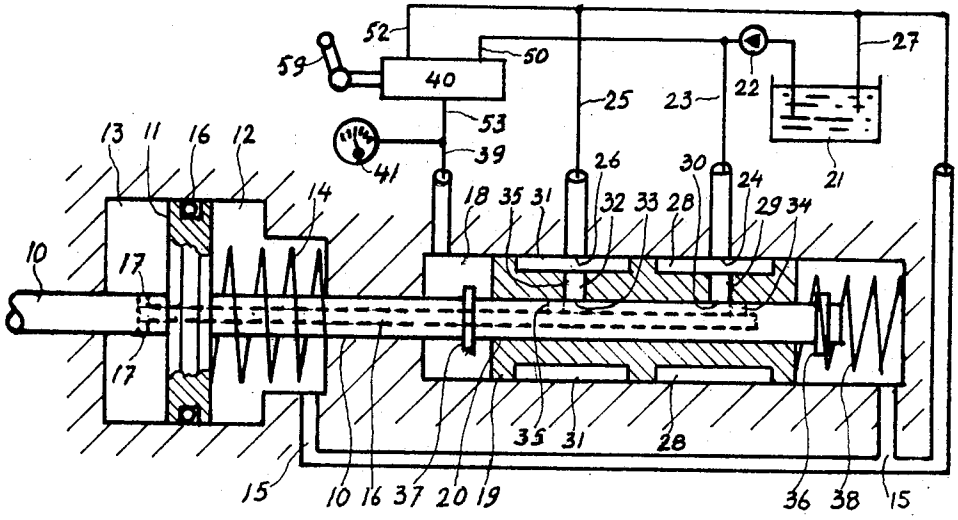


Fig. 1

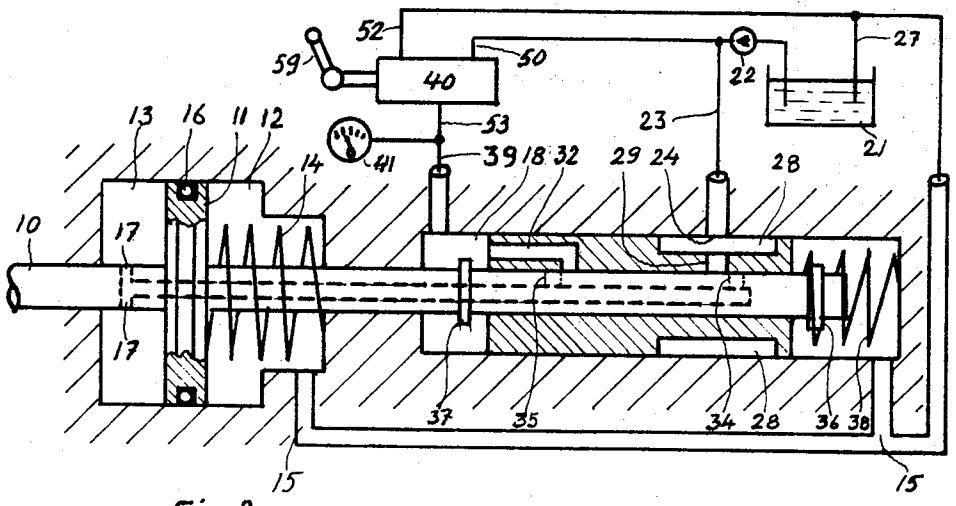


Fig. 2

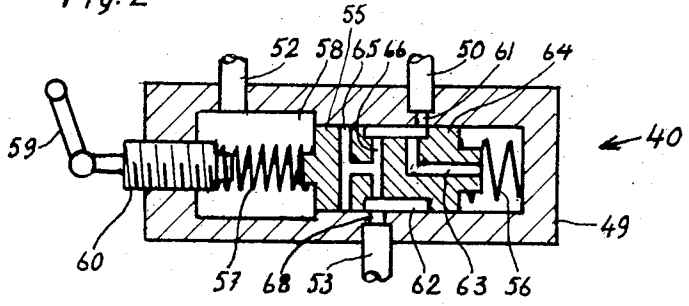


Fig. 3

INVENTOR:
BO KARL LORITZ ALMQVIST

BY:

Silverman & Cass

ATTORNEYS

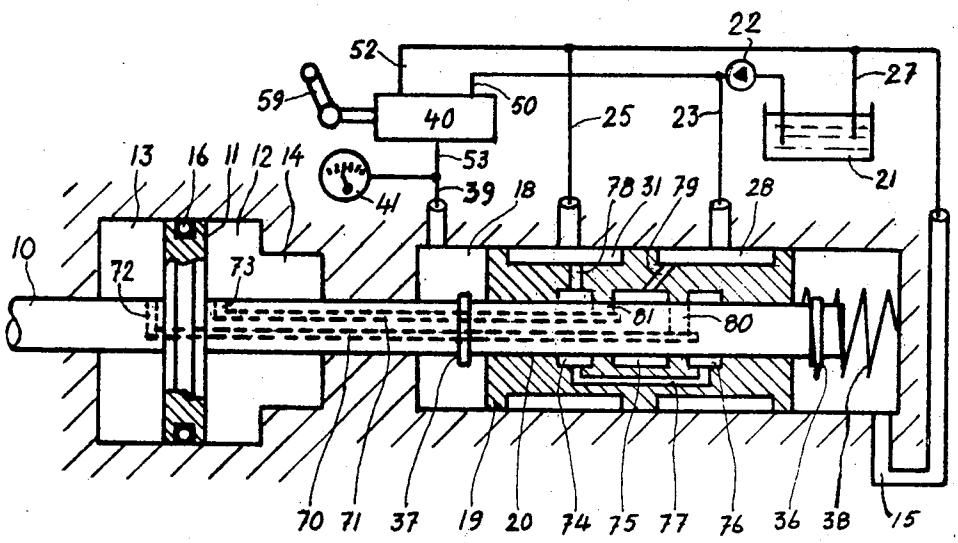


Fig. 4

INVENTOR:
BO KARL LORITZ ALMQVIST
BY:
McCormick & Cass
ATTORNEYS

# DEVICE FOR VARYING THE PITCH OF PROPELLER BLADES

The present invention relates to a device for varying the pitch of the propeller blades in engine driven boats. The rotating forces required for such adjustment are rather great even in boats with a relatively low engine power. Therefore, hydraulic adjusting devices are regularly used.

The hydraulic servo-motor which is used for this purpose is generally located in or adjacent to the boss for the propeller shaft. From a movement transmission device associated with the propeller blades a displaceable, reversal rod which is coaxial with the propeller shaft is connected to a working piston in a hydraulic working cylinder, to which hydraulic pressure medium is supplied.

In connection with this device a position valve or follow-up-valve is provided. The follow-up-valve comprises a follow-up slide located in an auxiliary cylinder, said slide cooperating with an extension of the piston rod of said piston projecting from the opposite side of the piston. This piston rod extension is provided with channels through which pressure medium is supplied to and removed from the working cylinder. The channels are provided with inlet and outlet openings which lead to openings in the surface of the piston rod extension and which cooperate with corresponding openings in the slide of the follow-up-valve.

Devices of this kind are already known and in these devices the position of the follow-up-valve slide has been manually controlled by a mechanical link rod, whereby the adjustment of the propeller blades has been made. The actual position of the link rod has also been an indication of the actual position of the propeller blades.

Said indication is, however, not reliable, because due to the great length of the link rod and the other mechanical transmission devices between the propeller blades and an indicator means, it has not been possible to avoid that said indication has been dependent of the temperature.

In order to avoid extended, mechanical transmission devices, it has been suggested to control the servo-motor hydraulically from a remote control station. For practical reasons it has, however, not been possible to obtain a continuously adjustable pitch varying device for the propeller blades in this manner and, therefore, one has been compelled to provide for a movement to a limited number of predetermined pitch angles of the propeller blades.

The present invention relates to a device for varying the pitch of the propeller blades in engine driven boats and the like by means of a hydraulic motor comprising a working cylinder provided with a working piston which through a mechanical transmission member imparts a movement to the propeller blades and an auxiliary cylinder with a follow-up slide which cooperates with a transmission device mechanically connected to the working piston, said transmission device having at least one channel for pressure medium through which the pressure medium is conducted to and from the working cylinder and inlet and outlet openings, respectively, connected to said channel for the pressure medium, said transmission member being slidably cooperating with the follow-up slide, said follow-up slide being displaceable in the auxiliary cylinder, said follow-up slide being further provided with inlet and outlet openings, respectively, for the pressure medium, said openings cooperating with the inlet and outlet openings respectively of the transmission member in such a manner, that the transmission device and consequently also the position of the working piston is determined by the position of the follow-up slide.



The invention is mainly characterized by the fact that the position of the follow-up slide is controlled by a control pressure medium which is active in a control pressure medium chamber in the auxiliary cylinder, the pressure of said control pressure medium being manually adjustable by means of a pressure control valve and also of a force which counteracts the pressure in the control pressure medium chamber.

In the following, some embodiments of the invention will be described more in detail with reference to the accompanying drawings, in which:

FIG. **1** illustrates diagrammatically a pitch varying device for propeller blades according to this invention, as seen in longitudinal section,

FIG. **2** illustrates diagrammatically a device according to a further development of the invention,

FIG. **3** illustrates diagrammatically a pressure control valve provided in the arrangement of FIG. **2** and

FIG. **4** illustrates a modified embodiment of the device according to the invention.

The device according to FIG. **1** comprises a transmission rod **10** which may be located within the propeller shaft and concentrically with the latter and, by further transmission devices not shown, for example teeth provided on the rod and gear wheels arranged on the shafts of the propeller blades, may be arranged to transmit torsional movement to the propeller blades **80** by longitudinal displacement of the rod **10** forwards and backwards. The mechanical details for translating the axial movement of the rod or shaft **10** to change of the pitch of blades is not part of the present invention, the same being well known in the art. For a more detailed showing and description, attention is directed to the Ekman U.S. Pat. No. 3,534,703, issued Oct. 20, 1970. It will be understood that both the propeller shaft and the rod **10** will be in rotation when the shaft is connected to the prime mover.

On the rod **10**, there is a working piston **11** fastened. The piston is slidable in a working cylinder **12** and is actuated at one side by a pressure medium in a working pressure medium chamber **13** and at the other side of a spring or the like **14**. At the side of the piston which is not exposed to pressure medium, there is a draining tube **15** provided, in order to remove pressure medium which may leak through the piston packing **16**. The piston rod **10** has an extension on the rear side of the piston and is provided with a concentric channel **16** through which pressure medium is transmitted to the working side of the piston. The piston rod has radial channels **17** through which pressure medium can stream out from the channel **16** and stream back again into the channel **16**. The extension of the piston rod projects into an auxiliary cylinder **18** and in this cylinder there is provided a displaceable follow-up slide **19**. The slide **19** is provided with a concentric bore **20** in which the piston rod is slidable.

From the pressure medium tank **21**, pressure medium is supplied through a pump **22** which generates a

high pressure, to a conduit 23 connected to the auxiliary cylinder 18 through an inlet opening 24. Pressure medium is removed through an outlet conduit 25 which is connected to an outlet opening 26. The outlet conduit 25 is connected to a return conduit 27 which leads to the pressure medium tank 21.

In connection with the inlet opening 24 for the pressure medium the slide 19 is provided with a pressure medium receiving annular channel 28 which through channels 29 leads to inlet openings 30 which normally are closed or substantially closed by the surface of the extension 10 of the piston rod.

In connection with the outlet opening 26 there is, in a corresponding way, an annular channel 31 in the slide 19, said annular channel being connected to a channel 32 which has an opening 33 which is normally closed by the surface of the extension 10.

The piston rod extension 10 is provided with radial channels 34 leading from the concentric pressure medium channel 16 to the outer surface of the piston rod extension. The opening of the radial channels 34 are located in the position illustrated in FIG. 1 i.e., just adjacent to the opening 30 of the channel 29 of the slide, so that by a very little displacement of the slide to the right or of the piston rod to the left there will be a connection between the channel 29 and the channel 34.

Further, the piston rod extension 10 has a radial channel 35 leading from the concentric channel 16 to the surface of the piston rod extension. This channel cooperates with an opening 33 of the channel 32 of the slide 19. By the slightest displacement of the slide to the left or of the piston rod to the right from the position shown in FIG. 1 there will be connection between the channel 32 and the channel 35.

The piston rod extension 10 is provided with stoppers 36 and 37 which limit the displacement of the slide 19 relative to the piston rod extension. The slide 19 is actuated at the right end thereof by a pressure spring 38 which is provided in an extension of the cylinder 18. On the left side the slide is actuated by control pressure from a pressure chamber 18.

Control pressure is supplied through the conduit 39 from the pump 22 through a pressure control valve 40. The pressure in the chamber 18 is indicated by a manometer or pressure gauge 41. The manometer 41 may be calibrated for directly indicating the pitch angle of the propeller blades because said angle is exactly defined by the pressure in the control pressure chamber 18 which will be understood from the following description.

In FIG. 3 there is shown a pressure control valve 40 which is suitable to be used in connection with a device according to FIG. 1.

The pressure control valve comprises a valve house 49 with an inlet 50 for pressure medium and an outlet 52 to which the draining conduit 27 in FIG. 1 is connected and a second outlet opening 53 to which the conduit 39 in FIG. 1 is connected.

The valve house 49 has a cylinder 54 in which a valve member 55 is slidable. The valve member is actuated at the right end thereof by a weak pressure spring 56 and at the left end by a stronger pressure spring 57. The pressure spring 57 is located in a space 58 which is a continuation of the cylinder 54 but which has greater diameter than the cylinder 54. To this space 58 the draining opening 52 is connected. The pressure of the pressure spring 57 may be adjusted by a handle 59, which actuates a screw 60 against which the pressure spring rests.

When pressure medium is supplied to the opening 50, said pressure medium flows through a channel 61 into an annular channel 62 on the surface of the slide 55. From this channel 62 there is a channel 63 leading to the right end of the slide. Therefore, pressure medium flows out through this channel 63 and this brings about that the slide is displaced to the left from the position shown in FIG. 3. When this occurs, a portion 64 of the slide 55 will be brought to cover the opening 61 from the pressure medium opening 50. At the same time as this occurs, a channel 65 which through channels 66 has connection with the annular channel 62, will reach the shoulder 67 where the cylinder 54 is connected to the space 58. Therefore, pressure medium will stream from the annular channel 62 to the space 58 and consequently the pressure within the annular channel 62 is decreased.

Of course, also the pressure on the right end of the slide 55 will decrease, whereby the slide again will be displaced slightly to the right and new pressure medium will be supplied from the opening 50. It is clear, that the position of the slide will be balanced when the pressure in the channel 62 is in a certain relation to the pressure which the spring 57 exerts to the slide 55. Therefore, the pressure in the channel 62 may be directly adjusted by means of the manual actuating device 59. The outlet opening 53 for pressure medium is connected to the annular channel 62 by a channel 68 and, therefore, the pressure in the conduit 39, FIG. 1, is equal to the pressure in the annular channel 62.

The device shown in FIG. 1 operates in the following way. The position shown in FIG. 1 is stable as long as the pressure in the pressure chamber 18 is constant. If the pressure in the pressure chamber 18 increases by actuating the handle 59 of the pressure control valve 40 (the spring 57, FIG. 3, is tightened) the slide 19 will be displaced to the right against the action of the spring 38. Thereby, the channel 29 of the slide will be put in connection with the channels 34 on the piston rod extension 10 and pressure medium will flow into the pressure chamber 13 behind the working piston 11, through the channels 24,34,16,17. Now, the working piston 11 will be displaced to the right against the action of the spring 14. This displacement will continue until the channel 34 again is out of connection with the channel 29. The mutual position of the slide 19 and the piston rod 10 has then been restored. This means, that the working piston 11 and the slide 19 has been displaced an equal distance to the right. This position is again stable and the only difference from the original position is that the pressure in the actuating pressure chamber 18 is greater, which is indicated by the manometer 41, and that the pitch angle of the propeller blades is different.

Correspondingly, if the pressure in the chamber 18 is decreased by a corresponding adjustment of the actuating device 59 (loosening the spring 57) in the pressure control valve 40, the slide 19 will be displaced to the left under the action of the spring 38. Thereby, connection will be obtained between the channels 32 in the slide 19 and the channel 35 in the piston rod extension 10. Now, pressure medium will be supplied from the

chamber 18 through the channels 17,16,35,32 to the draining conduits 25 and 27 to the pressure medium tank 21. Thereby, the working piston 11 will be displaced to the left under the action of the spring 14. This displacement will continue until the connection between the channel 35 and the channel 32 again is interrupted. The original mutual position between the piston rod 30 and the slide 19 has now again been restored. The only difference between the new position and the original position is that the pressure in the control pressure chamber 18 is decreased and that the piston rod 10 is displaced more to the left which means that the pitch angle of the propeller blades is different.

It is evident, that the adjustment of the propeller blades always is a direct function of the pressure in the pressure medium chamber 18 and therefore the pitch angle of the propeller blades may always be indicated by the manometer 41.

In FIG. 2 there is shown a modified embodiment of the invention. In this Figure the corresponding reference numerals as in FIG. 1 have been used.

The only difference between FIG. 1 and FIG. 2 is that in the device according to FIG. 2 the return pressure from the working cylinder is used as a control pressure for the adjustment of the slide 19 in the auxiliary cylinder. For this purpose the return channel 32 of the slide opens through the left end of the slide into the control pressure medium chamber 18. The function of the device shown in FIG. 2 corresponds entirely to the function of the device shown in FIG. 1. By means of the actuating device 59 the pressure in the control pressure chamber 18 may be increased whereby the slide 19 will be displaced to the right. Thereby pressure medium will be supplied to the cylinder space 13 in the working cylinder through the channels 23, 28,29,34,16,17. Thereby, the working piston 11 will be displaced to the right an equal distance as the slide 19 has been displaced in the cylinder 18 and therefore the connection between the channels 34 and 39 will be interrupted. In a corresponding way, pressure in the control pressure medium chamber 18 can be decreased by adjustment of the actuating device 59. Thereby connection will be made between the channels 32 and 35 whereby pressure medium is removed from the working cylinder 13 through the channels 17,16,35,32 and supplied to the control pressure chamber 18. From the control pressure chamber 18, pressure medium is supplied through the conduit 39 to the pressure control valve 40 and because the pressure from the spring 32 has been decreased by the adjustment of the control member 59, the slide 55 has been displaced so much to the left, that the channel 65 has been opened to the space 58 and consequently, pressure medium streams into the space 58 and further through the conduits 52 and 27 to the pressure medium tank 21.

In the embodiments so far described, there will be a balancing of the pressure from the spring 14 against the working piston 16 and the pressure from the spring 38 against the slide 19 so that a condition of equilibrium is obtained. The mechanical equivalence to the pressure transmitting devices between said spring pressures would be a lever in which the ratio between the length of the lever arms could be varied in a way corresponding to the adjustment of the pressure medium in the chamber 18.

In FIG. 4 there is illustrated a further embodiment, in which the working piston 11 is not actuated by any spring but by the pressure from pressure medium on both sides. In FIG. 4 the piston rod 10 is provided with two parallel pressure medium channels 70 and 71. The channel 70 is connected by a radial channel 72 to the space 13 on the left side of the piston and the channel 71 through another radial channel 73 is in connection with a space 12 on the right side of the piston. The slide 19 in the auxiliary cylinder 18 has three annular channels 74,75,76 in the surface which cooperates with the surface of the piston rod 10. The two outer annular channels 74 and 76 are connected with each other through a channel 77. Further, said channels are connected to an outer annular channel 31 through a radial channel 78.

The middle, annular channel 75 is connected to another outer annular channel 28 on the slide 19 by a channel 79.

To the channel 70 in the piston rod 10 a radial channel 80 is connected, which opens on the surface of the piston rod between the two annular channels 75 and 76. To the channel 71 in the piston rod 10 another radial channel 81 is connected, which opens on the surface of the piston rod between the annular channels 74 and 75 of the slide.

The device according to FIG. 4 operates in the following way. The position illustrated in the drawing is stable. If the pressure in the control pressure chamber 18 is increased by actuating the handle means 59 of the pressure control valve, the slide 19 will be displaced slightly to the right in relation to the piston rod 10. Thereby a pressure medium transmitting connection will be established between the annular channel 75 and the channel 80 and also between the annular channel 74 and the channel 81. Then the working pressure medium will be introduced at the left side of the piston 11 through the following transmission path: The conduit 23, the annular channel 28, the channel 79, the annular channel 75, the channel 80, the channel 70, the channel 72.

At the same time pressure medium will be removed from the right side of the piston 11 through the following transmission path: The channel 73, the channel 71, the channel 81, the annular channel 74, the channel 78, the annular channel 31, the conduit 25, the conduit 27. Consequently, the working piston 11 will be displaced so much to the right that the original relative position between the slide 19 and the piston 11 will be restored. Also in this case, the piston 11 will be displaced the same distance as the slide 19.

If the pressure in the control pressure medium chamber 18 is decreased by a corresponding adjustment of the manual actuating member 59 of the control pressure valve 40, the slide 19 will be displaced somewhat to the left on the piston rod 10 from the position shown in FIG. 4. Thereby pressure medium will be introduced on the right side of the piston 11 through the following transmission path: The conduit 23, the annular channel 28, the channel 79, the annular channel 75, the channel 81, the channel 71, the channel 73. At the same time pressure medium will be removed from the left side of the working piston through the following transmission path: The channel 72, the channel 70, the channel 80, the annular channel 76, the channel

77, the annular channel 74, the channel 78, the annular channel 31, the conduit 25, the conduit 27.

In this case the piston will be displaced the same distance to the left as the slide 19 has been displaced, and consequently, the original mutual position between the slide 19 and the piston rod 10 will be restored.

It is evident, that also in the embodiments according to FIGS. 2 and 4, the position of the working piston 11, and the pitch angle of the propeller blades, will be exactly defined by the pressure in the control pressure medium chamber 18. Therefore, also in these embodiments, the angle of the propeller blades will be directly indicated by the manometer 41.

The device according to the invention gives the advantages in comparison with arrangements hitherto known, that no extended mechanical link systems for the control device will be needed and a direct indication of the pitch angle of the propeller blades will be obtained without any mechanical transmission means of such dimensions, that the accuracy is affected by temperature variations.

The propeller shaft may also in this arrangement be made simpler because the device with the auxiliary cylinder 18 and the associated slide 19 will be arranged adjacent to the working cylinder 13 and the working piston 14 which in turn may be arranged in the propeller hub or very adjacent to the latter.

Different combinations of the described embodiments may be made within the scope of the invention. An especially advantageous device is obtained by combining the embodiments according to FIG. 2 and FIG. 4.

If, in the arrangement according to FIG. 4, the conduit 25 and the annular channel 31 are dispensed with, and the channel 78 in the slide 19 opens at the left end of the slide in the same way as the channel 32 in the arrangement according to FIG. 2, such a combination will be obtained. In this combination the pressure of the pressure medium which is removed from the working cylinder and which is present in the pressure chamber 18 will generate the pressure which defines the position of the slide 19, and consequently also of the working piston 11. This pressure is adjusted by means of the manual adjusting member 59 of the control pressure valve 40.

The advantage of utilizing the return pressure as a control pressure is that one needs only two pressure medium conduits to the auxiliary cylinder 18. In the devices according to FIG. 1 and 4 there are three conduits required.

Said combination between the devices according to FIGS. 2 and 4 will also being about the advantage which is obtained with the device according to FIG. 4 viz. that leak tendencies at the working piston are eliminated. The working piston is actuated by an equal pressure at each side of the piston.

Further, the counterforce which is acting on the piston and which in the device according to FIG. 1 and 2 is generated by a spring, may be made as great as needed without use of a strong and heavy spring.

Also other modifications of the invention may be made.

What we claim is:

1. A device for varying the pitch of propeller blades mounted for rotation about a pitch change shaft, said device comprising: an hydraulic motor having a piston connected to said shaft for movement therewith and slidable in a cylinder, means for changing the pitch of said blades upon movement of said shaft, an auxiliary cylinder having a follow-up slide positioned therein and having a pressure medium chamber adjacent an end face of said slide, said follow-up slide being slidably mounted on said shaft, said shaft having at least one channel extending longitudinally therein for conducting a pressure medium to and from the working cylinder, a pressure medium tank, control valve means mechanically independent of said slide for selectively admitting the pressure medium into said pressure medium chamber from said tank, the channel in said shaft being provided with inlet and outlet openings for access and egress of said pressure medium, said follow-up slide being displaceable in the auxiliary cylinder by pressure in the pressure medium chamber and also by axial movement of said shaft beyond a predetermined amount, said follow-up slide having inlet and outlet passageways adapted to cooperate respectively with the inlet and outlet openings of the channel in said shaft such that introduction of said pressure medium into said auxiliary cylinder will displace said slide to align a respective opening and passageway thereby permitting pressure medium to pass through said channel to said cylinder and thereby displace said piston and associated shaft to vary the pitch of said blades.

2. A device as claimed in claim 1 in which said passageways open into the pressure medium chamber, said pressure medium chamber being connected to a return conduit, said control valve means being in said return conduit, said control valve means having a spring actuated pressure control slide and an actuating handle whereby the pressure of the spring and also the return pressure of the pressure medium in the control pressure chamber are manually adjustable.

3. A device as claimed in claim 1 in which said follow-up slide is biased toward said pressure medium chamber by a pressure spring.

4. A device as claimed in claim 1 and further including a manometer provided with a scale between said valve and the pressure medium chamber and on which the actual pitch of the propeller blades is directly readable.

5. A device as claimed in claim 1 in which the piston is actuated by pressure medium on one side thereof and by a spring force on the other side thereof.

6. A device as claimed in claim 1 in which the follow-up slide operates to introduce pressure medium at one side of the working piston remove pressure medium from the other side of said piston through two different channels in the shaft.

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