United States Patent

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[54] CONTROLLABLE PITCH PROPELLER SYSTEM

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[30] **Foreign Application Priority Data**

Mar. 28, 1969 Norway 1311/69

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

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

[58] **Field of Search** 416/157, 31, 162, 156, 48, 416/49; 91/32, 33

[56] **References Cited**

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[57] **ABSTRACT**

A controllable pitch propeller assembly wherein the pitch of the blades is controlled by an hydraulically actuated piston and cylinder assembly. Auxiliary hydraulic supply means are provided for actuating the piston and cylinder assembly in the event the primary hydraulic supply fails.

5 Claims, 8 Drawing Figures

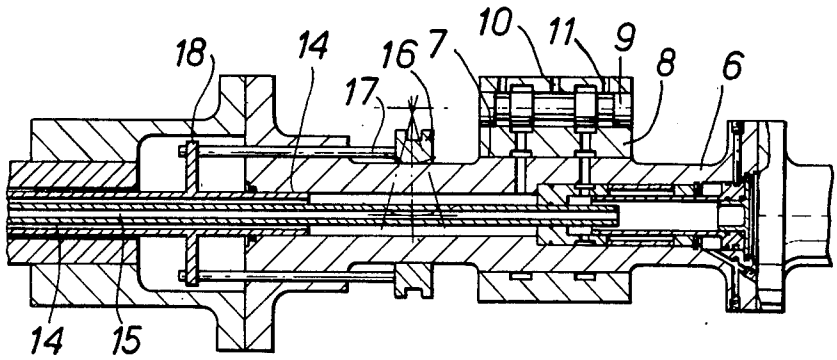

FIG. 1.

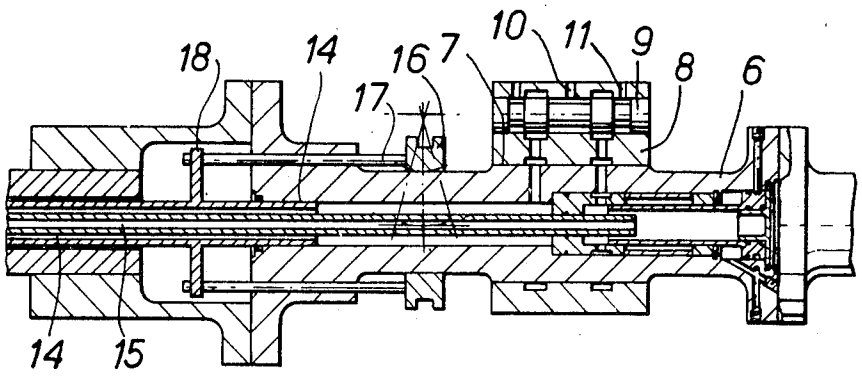

FIG. 2.

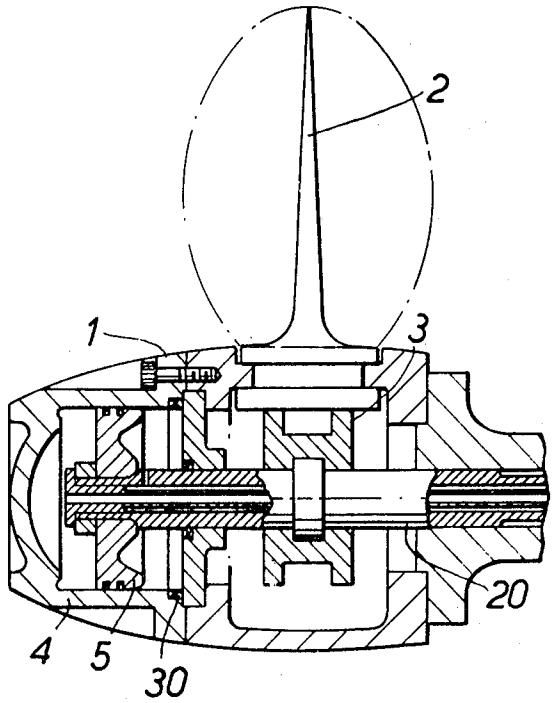

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FIG. 3.

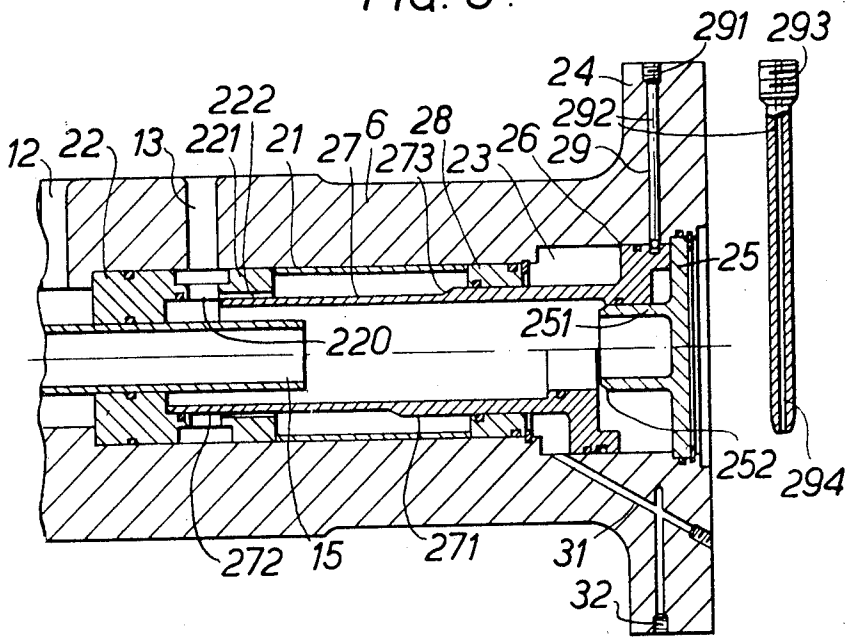

FIG. 4.

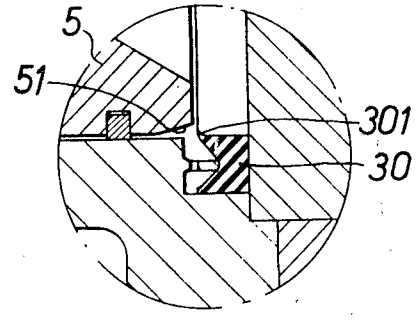

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FIG. 5.

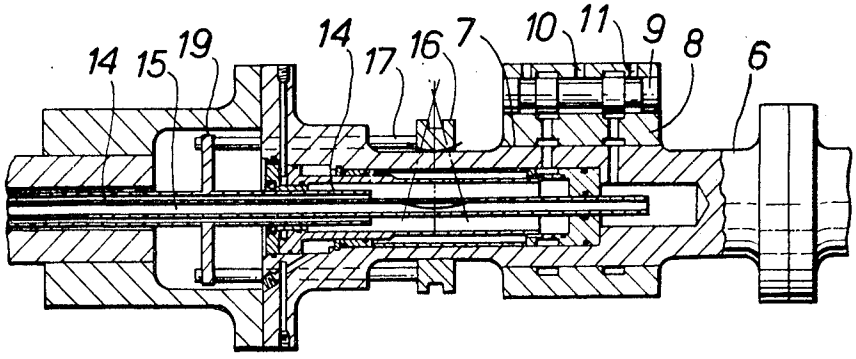

FIG. 6.

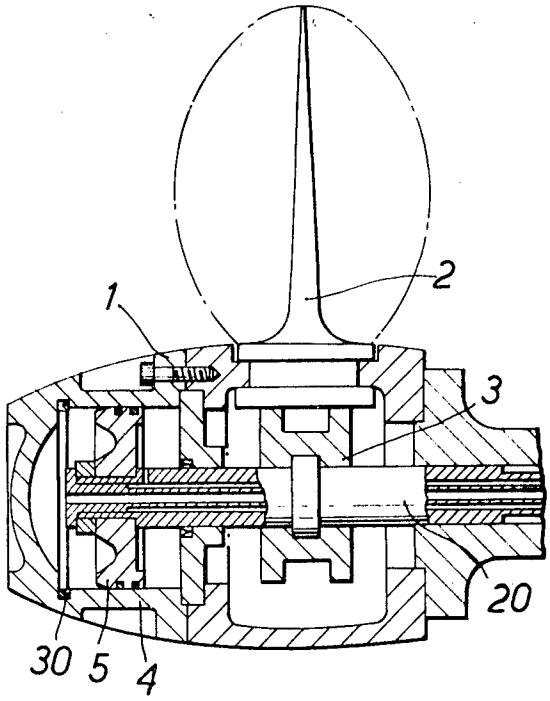

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FIG. 7.

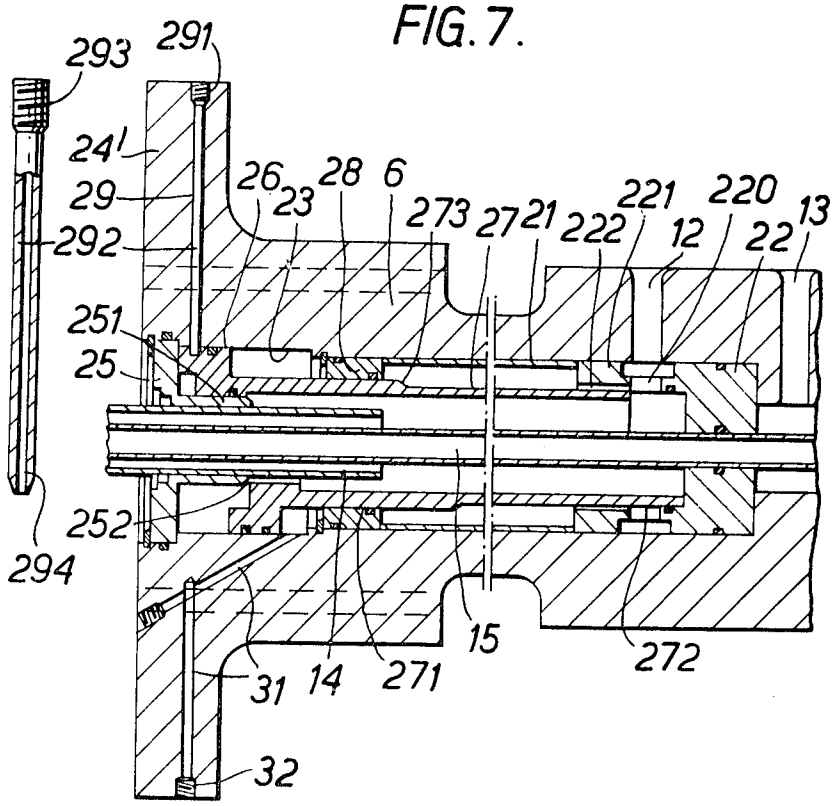
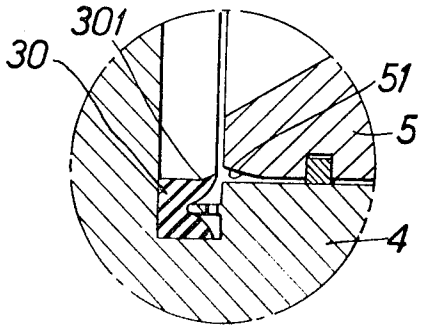


FIG. 8.



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CONTROLLABLE PITCH PROPELLER SYSTEM

The present invention relates to a controllable pitch propeller system, in particular adapted for use in seagoing vessels, of the type wherein the angular adjustment of the pitch of the propeller blades is controlled by a hydraulic servomotor system, from a pressure fluid source, such as a pump, possibly with a similar source in reserve. The servomotor system comprises, ordinarily, a cylinder and piston system, in which the piston rod is connected to the root of each of the propeller blades, so that the blade pitch depends upon the position of the servomotor piston in its cylinder. This position is determined by the supply of pressure fluid to either side of the piston in the cylinder, and such supply usually is controlled by means of a distribution slide valve and is effected through conduits extending axially in the propeller shaft. Customarily, the servomotor is positioned in the propeller shaft or in the propeller hub proper, and so arranged that a movement of the servomotor piston forwardly in the fore-and-aft direction of the vessel will cause an adjustment of the blade pitch in a direction for forward movement of the vessel, but it is also possible to so arrange matters that a forward adjustment of the propeller blades depends upon a rearward movement of the servomotor piston.

As mentioned, it is customary to provide a reserve pressure fluid source for the purpose of securing the operation of the servomotor system. The fact is that if a failure occurs in the pressure fluid supply, the propeller blades, due to the movement of the vessel forwardly through the water, will tend to turn into a position for rearward movement. The consequence is that the vessel looses its steering, and it is therefore of decisive importance that a failure in the pressure fluid supply be prevented. The provision of a reserve pressure fluid source will remedy a failure in the external supply. For the purpose of overcoming a failure in the immediate vicinity of, or in the distribution slide valve proper, or due to leakage in the introduction means, it has been suggested and used, systems of springs or hydraulic piston systems which, in case of failure, seek to cause the propeller blades to adopt a permanent position for forward movement. Such systems, which are adapted for direct, mechanical control of the servomotor must, necessarily, be rather strong, in order to overrule both friction in the interior of the propeller hub and the natural tendency, referred to, for rearward adjustment of the propeller blades, and they will also influence the ordinary operation of the entire propeller system.

The object of the present invention is a variable pitch propeller system of the type referred to above, wherein the structural and functional inconveniences of the previously known systems are avoided, the servomotor piston being subjected to no influence different from that present under ordinary operation.

According to the invention, the variable pitch propeller system comprises a means which, in emergency cases closes the line which ordinarily conveys pressure fluid to that side of the servomotor piston which induces forwardly adjustment of the propeller blades, and simultaneously opens a connection to an emergency supply of pressure fluid. Thus, in the operation of such a system, the servomotor piston, at a failure anywhere in the ordinary supply of pressure fluid, will be switched over from the ordinary pressure fluid source, possibly a reserve source, to an emergency source, independently of the ordinary distribution and introduction means, and the servomotor and adjustment means are continuously in condition for operation in the same manner as in ordinary operation.

According to the invention, the switching means comprises a floating piston, the rod of which, which is hollow, is adapted to simultaneously close the ordinary supply line of the pressure fluid to the servomotor space inducing forwardly adjusting of the propeller blades and to open connection between the said space and an emergency pressure fluid source.

For the resetting of the piston of the emergency slide valve means to the position to be adopted by the piston under normal operational conditions, the piston may be formed as a stepped piston, having one step surface adapted to be subjected to pressure from the ordinary pressure fluid supplied through the line for adjusting the servomotor piston for forward movement.

For the purpose of securing that the opening of the ordinary supply of pressure fluid be closed prior to the opening of the ordinary supply of pressure fluid be closed prior to the opening of the supply of emergency fluid, it is convenient to provide a phase displacement device, thereby that the hollow piston rod initially is guided on a stationary central projection, the length of which is such that the piston must have moved a certain distance before connection between the supply side of the piston and the hollow piston rod be opened.

When the servomotor piston is set in position for forward movement by means of an emergency setting means, for instance in the manner of the present invention, it is convenient to provide that the servomotor piston be locked in this position, so that the piston will remain in position for full forward movement. For this purpose, the servomotor cylinder may be provided, in front of the piston, with a sealing means which in cooperation with the piston is adapted to seal the piston when this reaches the position in which the sealing means is arranged. This cooperation may be facillitated by the provision of a chamfered circumferential surface on the forward end face of the piston, so that the sealing means will be wedged in between this surface and the cylinder wall. It is a fact that the ordinary piston rings will not provide perfect sealing, so that the piston may creep rearwardly, thereby necessitating one or more emergency setting, which obviously is not desirable.

In the accompanying drawings, two embodiments of the system according to the invention are schematically illustrated, viz one embodiment in which a forward adjustment of the propeller blades corresponds to a forwardly directed movement of the servomotor piston, and one in which such adjustment corresponds to a rearwardly directed movement of the piston.

The first embodiment is shown in the FIGS. 1 to 4.

FIG. 1 is an axial fore-and-aft sectional view of the portion of the propeller shaft comprising conduits for the supply and withdrawal of pressure fluid to and from respectively the servomotor which controls the propeller blade pitch.

FIG. 2 is an axial fore-and-aft sectional view of the propeller hub, and is to be presumed to be a left-hand continuation of the shaft portion shown in FIG. 1.

FIG. 4 is a detail view from FIG. 2, also in axial section.

The second embodiment is shown in the FIGS. 5 to 8.

In these FIGURES, the same reference numerals are used as in the FIGS. 1 to 4, applied to parts which correspond to each other, the only difference between the two embodiments being that the servomotor piston is moved in a rearward direction when forwardly adjusting the propeller blades.

FIG. 5 corresponds to FIG. 1, FIG. 6 to FIG. 2, FIG. 7 to FIG. 3 and FIG. 8 to FIG. 4.

As shown in the drawings, the system comprises in both embodiments a propeller hub 1 in which there is mounted a number of propeller blades 2 which may be turned in the hub 1 from settings for forward movement of the vessel to settings for rearward movement, and vice versa, by means of a crank head device 3, the setting of which is controlled by means of a servomotor which is mounted in the propeller hub 1 and comprises a cylinder 4 with piston 5. The setting of the piston 5, and thereby the angular setting (pitch) of the propeller blades 1 is controlled by means of a pressure fluid which is supplied to either side of the piston 5 through pipe lines accommodated in the hollow shaft 6, from an external pressure fluid source, merely indicated by its inlet openings 12 and 13, FIGS. 3 and 7.

A cylindrical portion 7 of the shaft 6 is freely rotatable in a stationary fluid introducing casing 8, accommodating a slide member 9 which is axially slidable. The casing 8 is provided with an inlet opening 10 for pressure fluid, and two outlet openings 11 leading to a sump, not shown. The casing 8 is also

provided with the inlet openings 12 and 13 referred to above, leading to the spaces to either side of the servomotor piston 5, through conduits accommodated in the shaft 6 through a tube 14, and through a tube 15, respectively, the tube 15 being centrally and axially mounted in a central bore in the shaft 6.

The slide member 9 is controlled in conventional manner under the use of a resetting means which comprises a ring 16 connected to rods 17 which are connected to a yoke 18 on the tube 14, the rearward (left-hand) end of which is secured to the hollow piston rod 20 of the piston 5 and the forward (right-hand) end is slideable with close fit. The piston rod 20 is the member which moves the crank head 3 for the adjustment of the pitch of the propeller blades 1.

The part of the system described so far, does not per se, form any part of the present invention.

In the system shown in the FIGS. 1 to 4, the bore in the shaft 6 comprises a large portion 21, extending from a forward (right-hand) point to a point situated between the inlet openings 12 and 13. The portion 21 is closed against a narrower portion of the bore between the openings 12 and 13, by means of a ring 22 which is provided with an opening 220 corresponding to the opening 13 in the casing 8. The ring 22 is provided with a central opening accommodating the tube 15 with close fit, the tube 15 terminating in an open end forward (to the right) of the ring 22.

The forward portion of the large portion 21 is provided with a portion 23 with a slightly greater diameter, and is closed in a flange 24 at the right-hand end of the shaft 6 by means of a plate 25 provided with a central, sleeve formed projection 251 extending rearwardly from the plate 25 and having a chamfered end surface 252.

In the portion 23 of the bore 21, there is provided a floating piston 26 having a hollow piston rod 27 of which a forward, thick portion 271 is displaceable with close fit in a stationary bushing 28 in the bore 21, and a rearward, thinner portion 272 displaceable with close fit in a cylindrical extension 221 of the ring 22. In this extension 221, there are provided axial grooves 222, so that the space of the bore 21 surrounding the piston rod 27 is communicating with the bore 13, to the effect that the position of piston 26 shown in the top part of FIG. 3, fluid is flowing from the opening 13 into the bore 21, both around and in the interior of the piston rod 27. The length of the projection 251 on the disc is so chosen relatively to the stroke length of the piston 26, 27, that when the piston rod 27 engages the ring 22 in the rearward, left-hand position of the rod, there will be a free flow section past the end surface 252, between the space on the front side of the piston 26 and the space inside the piston rod 27.

In the connecting flange 24 at the forward end of the propeller shaft 6, there is provided a radial bore 29 which is screw-threaded at 291 at the outer end. In ordinary operation, the bore 29 is closed by a pin 292 which is provided with a screw-threaded head 293 and with an air passage 294.

In the forward position of the piston 26, the bore 29 opens into the space 23 at the front side of the piston 26.

The flange 24 is also provided with an air passage 31 which opens into the space of the bore portion 23 at the rear side of the piston 26, and which may be closed by means of a plug 32 in the flange 24.

The forward end of the servomotor cylinder is provided with a U-formed joint 30, as shown at a greater scale in FIG. 4, and the forward end of the piston 5 is chamfered at 51. One lip 301 of the joint 30 extends somewhat into the free space in the cylinder 4, so as to engage the chamfered end of the piston 5 when the same is moved to a forward end position, and to slide upwardly along the circumferential surface of the piston 5.

In the embodiment of the system according to the invention which is shown in the FIGS. 5 to 8, the arrangement is, as mentioned, such that the servomotor piston 5 is moved rearwardly, to the left in the drawing in its cylinder 4, when the propeller blades are to be adjusted towards ahead movement of the vessel. Consequently, the joint 30 and the chamfered end 51 of the piston are here situated in the rearward, left-hand end of the cylinder 4. The disposition of the auxiliary piston 26 is therefore reversed relatively to the disposition shown in the FIGS. 1 to 4, i.e., arranged in the left-hand connecting flange 24' of the shaft 6, instead of in the right hand flange 24.

In this case the communication between the tube 14 and the opening 12 which is to be broken and replaced by a connection to an emergency source, through the bore 29. Structurally, this amended arrangement involves that the tube 14 is in slide fit engagement in the projection 251, while the tube 15, in this case also, is in slide fit in the ring 22.

The remaining details of this second embodiment are in complete accordance with those of the embodiment shown in the FIGS. 1 to 4, described above.

The system of the invention operates in the following manner:

In ordinary operation, the openings 12 and 13 are communicating with an extension pressure fluid source, and by a suitable displacement of slide member 9, such fluid is directed to the front or back side of the servomotor piston 5, for the purpose of adjusting the pitch of the propeller blades 2 to rearward and forward movement, respectively of the vessel. In such ordinary operation, the system functions in a well-known manner, so that a closer description of the system and its functions is considered not to be required by a man skilled in the art.

If now a failure or breakdown should occur in connection with the inlet casing 8, or in the supply of pressure fluid from the main or emergency source, the propeller blades will tend to change their pitch to a position for rearward movement of the vessel, to the effect that the vessel will loose its steering. This inconvenience is overcome by means of a system according to the present invention, in the following manner:

The pin 292 is screwed out of its bore 29, and a hose leading to any pressure fluid source is screwed into the threads 291. At the same time, the bore 31 is opened by removal of the plug 32.

When now the pressure fluid is introduced through the bore 29, the piston 26 is moved to the left in FIG. 3 and to the right in FIG. 7, so as to adopt the position shown in the lower part of FIG. 3 and FIG. 7, respectively, with the piston rod 27 in engagement with the ring 22. Thereby, the communication between the opening 13 and the space inside the piston rod 27 is broken and so also the communication to the tube 14, while a free path is established from the bore 29, through the space on the front side of the piston 26, the space inside the piston rod 27, the tube 15 to the rear side of the servomotor piston 5, so that the latter is so displaced that the propeller blades 2 are adjusted to a setting for full forward movement.

Hereby, the cylinder 4 and the ordinary adjustment mechanism are so dimensioned relatively to each other that the piston 5, in ordinary operation, will not attain its extreme position in the cylinder 4. Through the influence of the pressure fluid through the bore 29, the piston 5 is moved to its extreme, foremost or rearmost, respectively, position, in which the lip 301 of the seal 30 will enter the chamfered portion 51 of the piston 5 and engage the cylindrical circumferential surface. In this manner, it is prevented that any leakage of pressure fluid may occur from the rearside of the piston 5 with the consequental tendency of the piston 5 to sag rearwardly. With the piston in this extreme position and consequently with the propeller blades 2 in extreme forward setting, the supply of pressure fluid through the bore 29 is discontinued and the bore 29 is closed with a sealing pin or by a nonreturn valve.

The propeller blades 2 are now set in an extreme forward position. The vessel has full steering capacity, just like a vessel provided with propeller with a constant blade pitch, nd the steering may be effected by means of the propulsion motor, in a fully ordinary manner.

When the failure in the ordinary pressure fluid supply is repaired, the plug 32 is again removed from the bore 29 and pressure is again supplied through the opening 13. This pressure will be transmitted through the grooves 222 and act upon the surface 273 which defines the thickest portion 271 of the

piston rod **27** as against the thinner portion **272**, so that the piston **26** is pushed towards forward position, until readopting the position shown in the top portion of FIGS. **3** and **7**, and ordinary operational condition is reestablished. When the piston **26** has reached its forward end position, the pin **291** is again put into its place, and the opening **31** is closed by means of the plug **32**. If difficulties are met in the returning of the stepped piston **27** to the extreme forward position, pressure is again introduced through the bore **31**. This pressure will influence the rear side of the piston **26** and push the piston towards its end position.

In the embodiment shown in the FIGS. **1** to **4**, it is presumed, as mentioned above, that the servomotor piston is to move in the forward direction, to the right in the drawing, when the propeller blades are to be turned towards a forward setting. The auxiliary piston **26** is then positioned forward of the servomotor system.

However, if the servomotor system is of the type wherein an adjustment of the propeller blades towards a forward position is caused by a rearward, to the left, movement of the servomotor piston **5**, the auxiliary system is positioned rearwardly of the casing **8**, as shown in the FIGS. **5** to **8**.

I claim:

1. Controllable pitch propeller mechanism comprising:

a hollow, rotatable shaft;

a propeller hub mounted on one end of the shaft for rotation therewith;

a plurality of elongated propeller blades mounted on said hub and extending radially outwardly therefrom, said blades being rotatable about their longitudinal axes relative to said hub;

a first piston and cylinder assembly disposed within said shaft adjacent said hub, said first assembly including a cylinder extending longitudinally of the shaft and having a pair of longitudinally spaced fluid ports communicating with the interior thereof, and a piston disposed between said ports for movement longitudinally of the cylinder, said piston being operably connected to said blades for rotating the latter about their longitudinal axes during said movement of the piston;

a pressure fluid supply system including a source of pressurized fluid and a fluid return;

valve means operable intercommunicating said fluid supply system and the ports of the piston and cylinder assembly, said valve means being operable for alternatively connecting either of said ports with said source of pressurized fluid while simultaneously connecting the other of said ports with said fluid return, there being a fluid passageway extending between each of said ports and said valve;

a slide valve assemblage comprising a second cylinder and piston assembly disposed in the propeller shaft, said second assembly comprising a piston member movable axially of said shaft between two extreme positions, said member being provided with a hollow cylindrical skirt having an open end extending toward and opening into one of said passageways, said skirt being disposed, when said piston member is in one of its extreme positions, to block said one passageway between said valve means and the hollow space within said skirt with the latter remaining in fluid communication with said passageway and its port,

the cylinder of the second assembly being provided with an inlet communicating with the cylinder space on the side of the piston member remote from said passageway, said inlet being connectable to a second source of pressurized fluid, said second assembly including passage defining means disposed for intercommunicating said cylinder space with said hollow space of the piston member when the latter is in said one extreme position.

2. Mechanism as set forth in claim **1** wherein said piston member has a stepped configuration presenting an annular piston face on the external surface thereof facing a space communicating with said blocked passageway between the piston member and the valve means.

3. Mechanism as set forth in claim **1** wherein the cylinder of the slide valve assemblage has an end wall provided with a centrally protruding portion, said piston member having a central bore disposed at the opposite end thereof from said skirt, said protruding portion being disposed and configured to cooperate with said central bore to close said cylinder space during the initial movement of the piston member under the influence of fluid from said second source.

4. Mechanism as set forth in claim **1** wherein the cylinder and piston of the first assembly are provided with interengaging sealing members for securing and sealing said piston when the latter is in the position it assumes under the influence of pressure exerted through said one passageway from said second source.

5. Mechanism as set forth in claim **4** wherein the sealing member of said piston comprises an annular, chamfered surface.

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