SAFETY DEVICE FOR VARIABLE PITCH PROPELLERS

Main Hydraulic Pressure Supply

Auxiliary Hydraulic Pressure Supply

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A safety device for variable pitch marine propellers comprises, among other things, a preferred embodiment of the invention, a hub, propeller blades rotatably mounted in the hub for adjustment of their pitch, and a fluid motor located in the hub to effect such adjustment. A second fluid motor is normally inoperative, but, upon failure of the first motor, operates, independent of the first motor, to move the propeller pitch to one providing forward movement of the ship, regardless of the pitch then established by the main pitch-control system.

The mechanisms used to vary the pitch of marine propellers generally include a fluid motor. In such systems the working fluid is supplied from a pump that is driven by an electric motor, or by a transmission connected to the propeller shaft, or by the engine of the ship. The piston of the motor is arranged to adjust the pitch of the propeller blades as it slides along the cylinder.

From a safety standpoint, the problem with these devices is that if the fluid motor should fail, the propeller cannot be adjusted. This could result in serious consequences arising from the lack of maneuverability of the ship, particularly if the failure should occur while the propeller is set in a neutral or astern position.

Attempts to provide safety devices solving this problem have heretofore been made, but none has proved entirely successful. According to one proposed solution, the piston of a fluid motor is located in a part of the propeller shaft that is relatively accessible from the inside of the ship and which is connected to a pitch setting mechanism located in the hub by a rod slidably mounted in the shaft. Several disadvantages result from this type of arrangement. For one thing, the rod must be very strong to transmit the necessary force to the propeller while it is under load, that is, rotating. Also, if the propeller shaft should become bent as a result of an accident, the rod will be stuck so that the blades cannot be adjusted. Another proposal is to provide springs in the propeller hub, but this is acting on the fluid motor piston in a manner to shift the blades to their ahead pitch. This expedient does not work unless the propeller is stopped and not under load, which may take too long a time to be useful in an emergency situation.

There is provided, in accordance with the invention, a safety device that performs as aforesaid and overcomes the shortcomings of those suggested previously. The main pitch-changing equipment includes a fluid motor mounted in a cylinder carried in the hub of the propeller or in a part of the propeller shaft adjacent the hub and having a piston rod or other means which is connected to pivotable propeller blades to vary their pitch. At a proper place on the propeller shaft at a point within the ship's hull is a second, auxiliary fluid motor which is coupled by a pulling rod to the main fluid motor. During normal operation of the piston of the main motor, the auxiliary motor is inactive, but upon failure of the main propeller blades to vary their pitch. At an appropriate place on the propeller shaft at a point within the ship's hull is a second, auxiliary fluid motor which is coupled by a pulling rod to the main fluid motor. During normal operation of the piston of the main motor, the auxiliary motor is inactive, but upon failure of the main propeller motor to the ahead pitch position. The auxiliary motor is preferably connected to a backup fluid-pressure supply so that upon failure of the main fluid-pressure supply, the safety, backup motor can be operated.

One advantage of the invention is that the pulling rod associated with the auxiliary motor need not be as rigid as the rod in the previously proposed construction referred to above, since the force required to move the propeller blades by the pulling rod involves pulling, i.e., tension, only. The rod may, therefore, have a relatively small cross-sectional area since it is not subjected to compression (buckling) loads; indeed, one of the supply pipes serving the main fluid motor may be used as the connecting or pulling rod in the mechanism of the invention.

For a better understanding of this invention, reference is made to the following description of an exemplary embodiment, taken in conjunction with the accompanying drawings, a longitudinal, axial cross-section of a propeller mechanism according to the invention.

Before specifically describing the exemplary embodiment of the invention, it is to be understood that the expressions "forward" and "aft" refer to the location of the propeller mechanism on a ship. The propeller is usually mounted aft of the ship, and, in the drawing, the forward part of the propeller equipment is shown at the right and the aft part at the left.

As shown in the drawing, a propeller mechanism, shown generally at 1, includes blades 3 journaled in a hub 5 carried by a shaft 15 which is connected to the engine of the ship. Inside the hub 5, there is a fluid motor 7 for adjusting the pitch of the blades which comprises a cylinder 9 and a piston 11. The piston 11 is mechanically coupled, in the usual way, to crankpins 13 carried by the blades 3 so as to transmit the adjusting force to it.

The main fluid system, that is, the one operating the propeller 7, includes a conduit 35 that extends along a bore 17 in the shaft 15 and through the piston 11 so as to provide a fluid passage to the aft side of the cylinder. At its forward end, the conduit 35 carries an end piece 37 with a transverse pin 39 fixedly secured to and extending from its outer periphery. The purpose of the pin 39 will be fully explained hereinafter.

At the forward end of the propeller shaft 15, there is a second hydraulic cylinder 23, in which a second piston 25 with a sleeve-shaped piston rod 27 is axially movable, so as to provide an emergency fluid motor 33. The hydraulic cylinder 23 is provided with a non-return valve 29 and a safety valve 21, the function of which will be fully explained hereinafter. At the aft end of the sleeve there is provided a pair of slots 41 and since the former overlaps and slidably receives the conduit 35, the pin 39 projects through the slots 41 and forms a force transmitting mechanism between the emergency motor 33 and the main motor 7.

In order to control the main fluid flow, the motor 7 communicates with a non-rotating oil distribution box 43 which is carried in bearings on the propeller shaft 15. Ring-shaped seals 49, located between the distribution box 43 and the shaft 15, provide two ring-shaped chambers 45 and 47. Connecting the chamber 45 to a pressure source (not shown), is a pipe 51 extending through the distribution box; and, a pipe 53 connects the chamber 47 with a discharge tank (not shown). Radial hole 19 in the propeller shaft 15 communicates with chamber 45 and radial hole 21 connects the chamber 47. Also, communicating with the chamber 47, is an opening 59 in the conduit 35. Between the radial holes 19 and 21, there is a seal 55 carried between the pipe 35 and the surface of the bore 17; and a corresponding ring-shaped seal 57 is provided between the pipe 35 and the surface of the bore 17 at a point forward of bore 21. The seals 55 and 57 allow axial movements of the pipe 35 in the bore.
The motor 7 is arranged so that the blades 3 can be adjusted to various pitches for movement ahead or astern at various speeds. When no propeller thrust is desired, the blades 3 can be set to zero pitch. Every pitch setting of the blades 3 corresponds to a certain position of the piston 11 in the cylinder 9 and in the embodiment, adjustment of the blades 3 to maximum pitch for running ahead corresponds to the forward end position of the piston 11 in the cylinder 9, and the adjustment of the blades 3 to maximum pitch for running astern corresponds to the rearward end position of the piston 11 in the cylinder 9.

When the hydraulic main control system of the propeller mechanism works as intended, the piston 25 of the emergency motor 33 rests in its aft end position in the hydraulic cylinder 23 and does not affect the operation of the propeller mechanism.

The pitch setting of the blades 3 by means of the main control system is effected as follows: when the blades 3 are to be turned to a forward or increased pitch, working fluid is conducted from the pressure oil pump through a regulating valve and the piping 53 to the forward ring-shaped chamber 47 of the distribution box 43. From this chamber, fluid flows through the radial hole 21 in the shaft 15 to the axial bore 17 and through the opening 59 and the pipe 35 to the aft side of the piston 11 in the cylinder 9. At the same time, fluid is discharged from the cylinder space forward of the piston 11, through the space between the outside of the pipe 35 and the surface of the bore 17 to the axial hole 21 to the ring-shaped chamber 45 of the distribution box 43. From this chamber 45, the fluid is conducted through the piping 51 over the regulating valve to an oil tank. The fluid flow is controlled by the regulating valve, which is operated by a suitable control device. When the piston 11 reaches its desired position, the regulating valve closes both the fluid supply to and the discharge from the cylinder 9 so that the propeller blades 3 will be locked in position.

When the blades 3 are to be set to a reverse or reduced pitch, the piston 11 has to be moved aft. To do this, the regulating valve conveys fluid from the pump to the forward side of the piston 11 and discharges fluid from the aft side of the piston 11. The direction of the fluid flow in the main system is then reversed, compared to the direction of the fluid flow when the piston 11 has to be moved forward.

During all movements of the piston 11, the pipe 35 moves axially in the bore 17 of the propeller shaft 15 and the end piece 37 moves axially in the sleeve-shaped piston rod 27. If the piston 25 is placed in its aft end position in the cylinder 23—as it should be when the safety device does not need to be used—the slot 41 in the sleeve 27 is in such a position that the pin 39 does not affect it when the end piece 37 moves.

In case the main control system fails, the safety device will be used in the following way: the propeller will be stopped and, by means of the regulating valve, fluid will be drained from the system. The non-return valve 29 will be connected to an emergency source of pressure, for example, a hand operated or pneumatic pump, and fluid will be pumped into the hydraulic cylinder 23 moving the piston 25 with its piston rod 27 forward. When the end of the slot 41 reaches the pin 39, the end piece 37 is moved forward and the pipe 35 will be subjected to a pull, causing the piston 11 to move forward turning the propeller blades 3 to a position for running ahead. When the propeller blades 3 have reached desired position, the emergency source of pressure is disconnected from the non-return valve 29 and the ship's engine started. The safety valve 31 limits the power of the emergency motor 33 so that stress in the pipe 35 will not become too big. If a rapid changeover is desired, the emergency motor can be connected to the emergency pump when it is installed and the stoppage time will be drastically reduced.

Since most propeller mechanisms are rather heavy, it is desirable to have a motor driven pump and since a failure of the main control system may occur simultaneously with an electric failure, the emergency pump should be driven by compressed air.

The present invention can also be used in propeller systems of somewhat different design than that described above, for example, systems where the blades are adjusted by a motor comprising one cylinder with two pistons, or to systems in which the blades are adjusted by means of several cooperating motors. In such systems, a pulling rod should be connected to at least one of the pistons in such a way that when being moved forward, the blades are adjusted for running ahead.

While in the foregoing there has been described a preferred embodiment of the invention, various modifications and uses, for example, water turbines and pumps, may become apparent to those skilled in the art to which this invention relates. Accordingly, all such modifications and uses are included within the intended scope of the invention as defined by the following claims.

I claim:

1. A safety device for variable pitch marine propellers comprising propeller blades pivoted in a propeller hub, means including a hydraulic piston servomotor constituting part of a hydraulic main control system and located in the propeller hub for pivoting the blades to adjust their pitch, the hydraulic piston servomotor including a main piston movable to adjust the pitch of the propeller blades to positions for movement of the ship ahead when the piston is moved forward, and an emergency servomotor including a pulling rod mechanically connected to the main piston and axially movable in an axial bore in the propeller shaft, an emergency piston member separate from the pulling rod, and a lost motion coupling between the piston member and the pulling rod, which coupling is arranged to be operable in a first position of the piston member to allow relative movement between the piston member and the pulling rod in a second position of the piston member to exert tension on the pulling rod effective to move the propeller blades to a forward pitch position.

2. A safety device according to claim 1 wherein the pulling rod is a pipe for conveyance of hydraulic pressure medium to, or from, the piston servomotor of the hydraulic main control system for adjustment of the propeller blades.

3. A safety device according to claim 1 wherein the emergency servomotor includes a hydraulic cylinder located in the propeller shaft, wherein the emergency piston member is axially movable in the hydraulic cylinder, and wherein the lost motion coupling includes a sleeve-shaped piston rod having at least one longitudinal slot intermediate the ends thereof, and a carrier key which protrudes radially through said slot.

4. A safety device according to claim 3 wherein the hydraulic cylinder includes a safety valve whereby to limit tensile stress in the pulling rod by setting a maximum hydraulic pressure in the emergency servomotor hydraulic cylinder.

5. A safety device according to claim 1 wherein the cylinder of the emergency servomotor is connected to a pressure pump and an oil tank, both of which are stationarily assembled on the propeller shaft for rotation therewith.

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