United States Patent [19]

Blickle

[11] **3,895,598**

[45] **July 22, 1975**

[54] **SHIP PROPULSION UNIT HAVING A VARIABLE PITCH PROPELLER**

[75] Inventor: **Karl Blickle,** Bolheim, Germany

[73] Assignee: **J. M. Voith GmbH,** Heidenheim, Germany

[22] Filed: **Feb. 19, 1974**

[21] Appl. No.: **443,316**

[30] **Foreign Application Priority Data**

Feb. 23, 1973 Germany 2308931

[52] **U.S. Cl.** **115/35;** 416/147

[51] **Int. Cl.** **B63h 1/14**

[58] **Field of Search** ..... 115/34 R, 34 A, 35, 37, 115/41 R, 42; 416/147, 157, 174; 114/150

[56] **References Cited**

UNITED STATES PATENTS

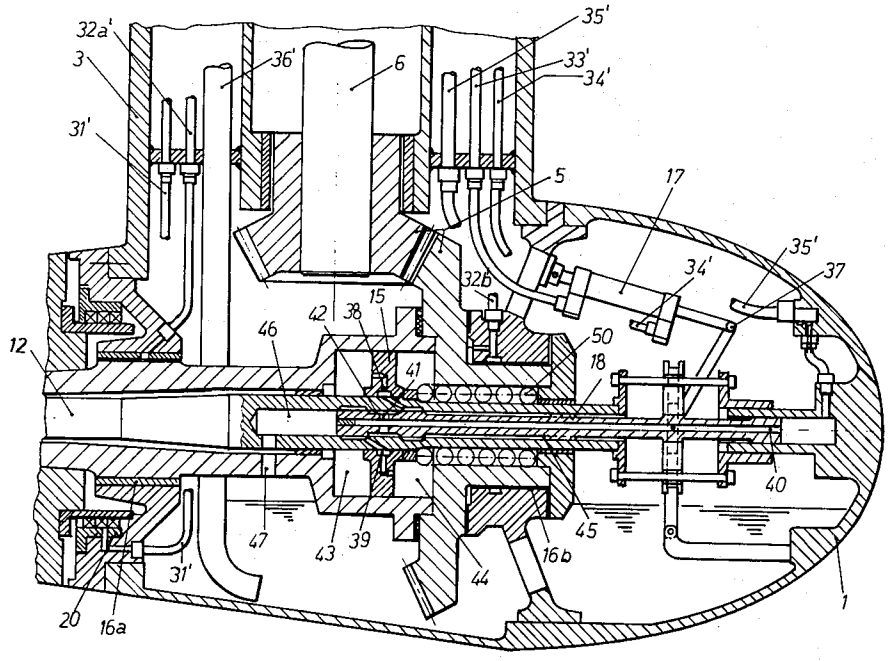
2,458,813	1/1949	Wanzer	115/35
3,266,454	8/1966	Sterling et al.	115/35
3,376,842	4/1968	Wynne	115/35
3,534,703	10/1970	Ekman	115/35
3,762,359	10/1973	Jones	115/34 R

Primary Examiner—Duane A. Reger
Assistant Examiner—Jesus D. Sotelo
Attorney, Agent, or Firm—Edmund M. Jaskiewicz

[57] **ABSTRACT**

A ship propulsion unit comprises a variable pitch propeller supported in a hub mounted on the lower end of a hollow member which is pivotably supported in a fixed housing such that the hollow member and hub are both pivotable about a vertical axis. A coaxial drive shaft for the propeller is enclosed within the hollow element. A plurality of pairs of sealing rings are provided between the hollow member and a portion of said fixed housing to define a plurality of annular chambers through which pass a number of supply and return lines for several fluid pressure systems which lead to the propeller and a servo motor for adjusting the pitch of the propeller blades.

3 Claims, 4 Drawing Figures



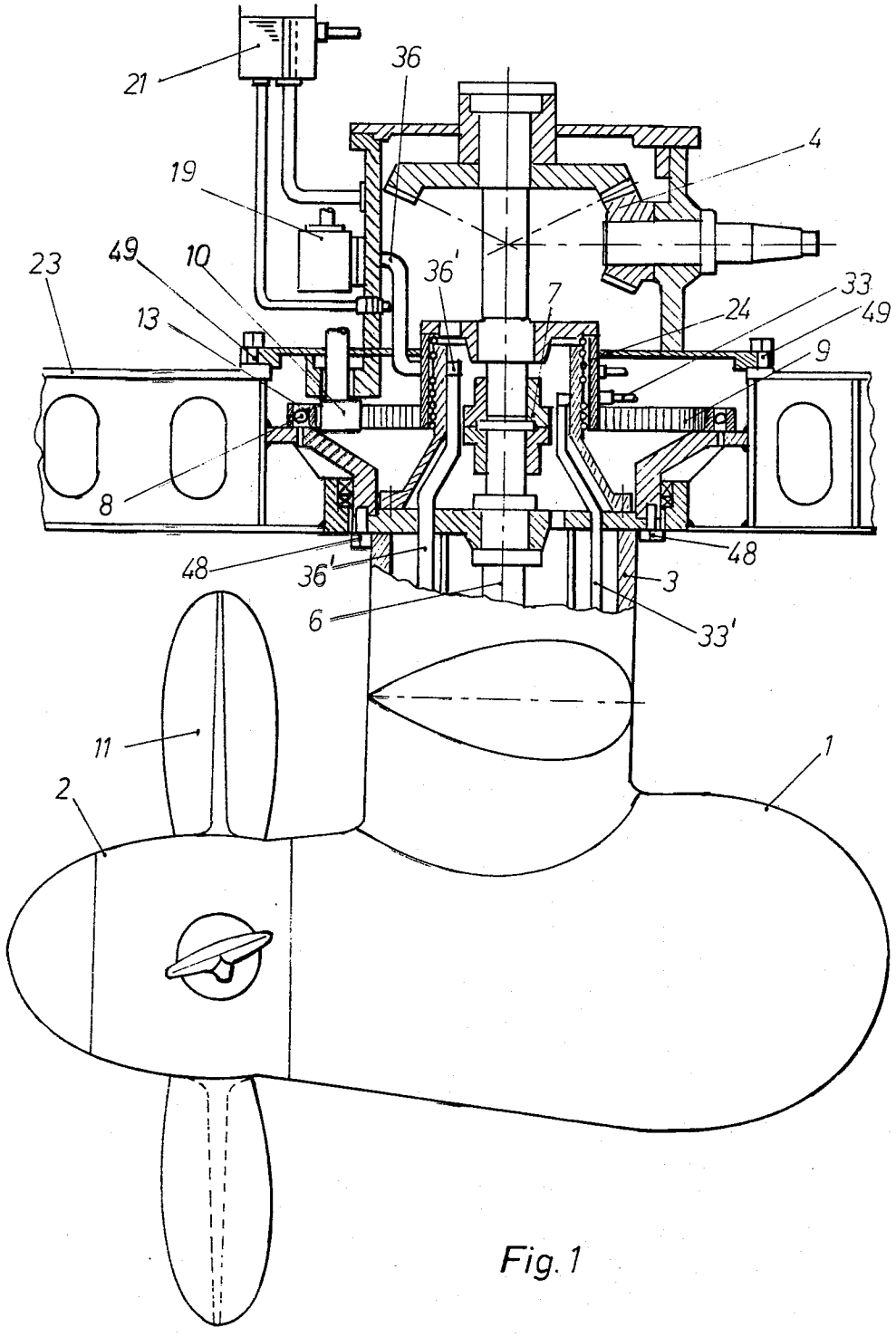


Fig. 1

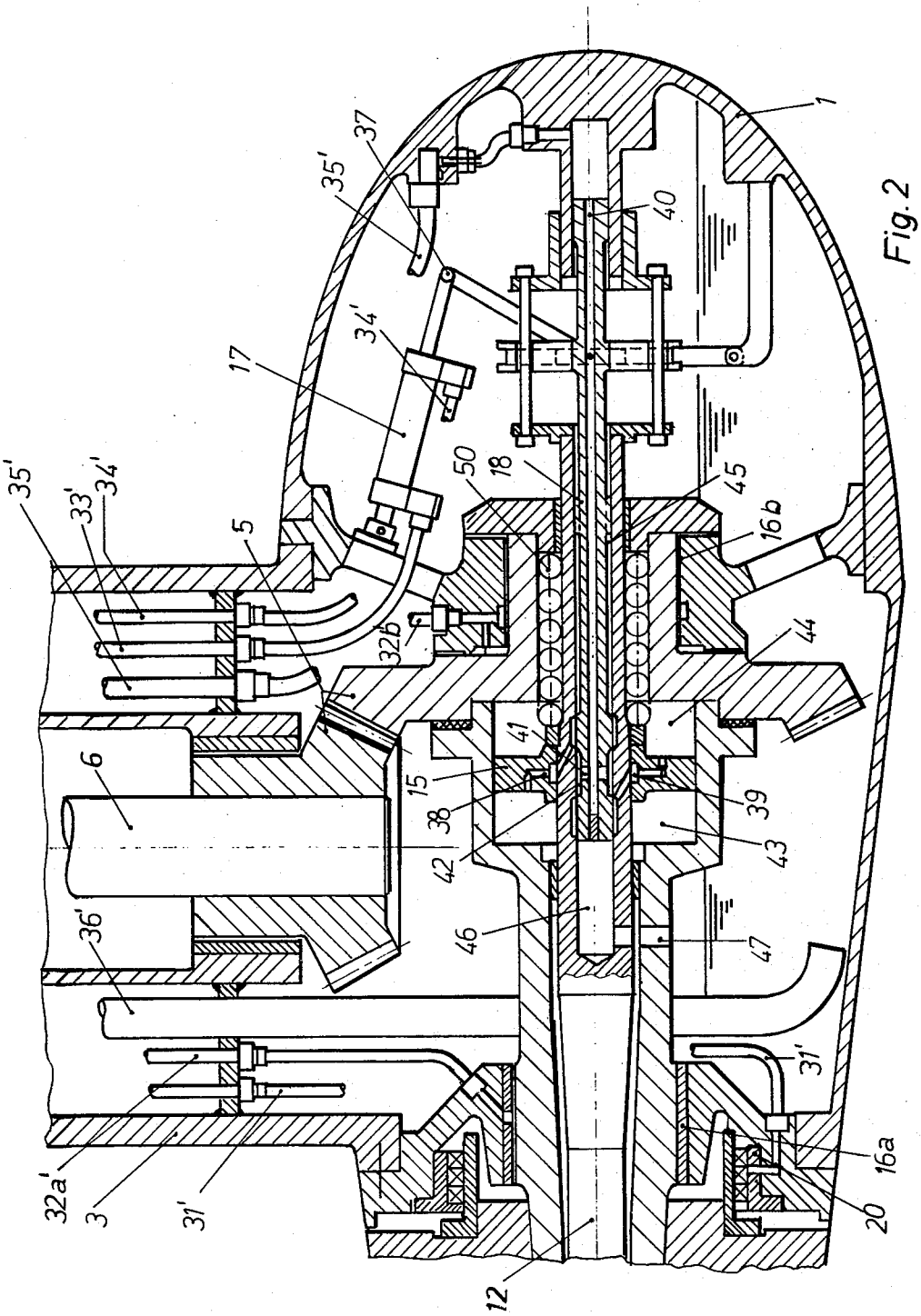

1
37
35'
40
34'
17
50
18
45
16b
35'
33'
34'
5
32b
44
41
6
15
38
39
43
42
46
47
36'
31'
16a
32a'
3
31'
20
12

Fig. 2

Fig. 3

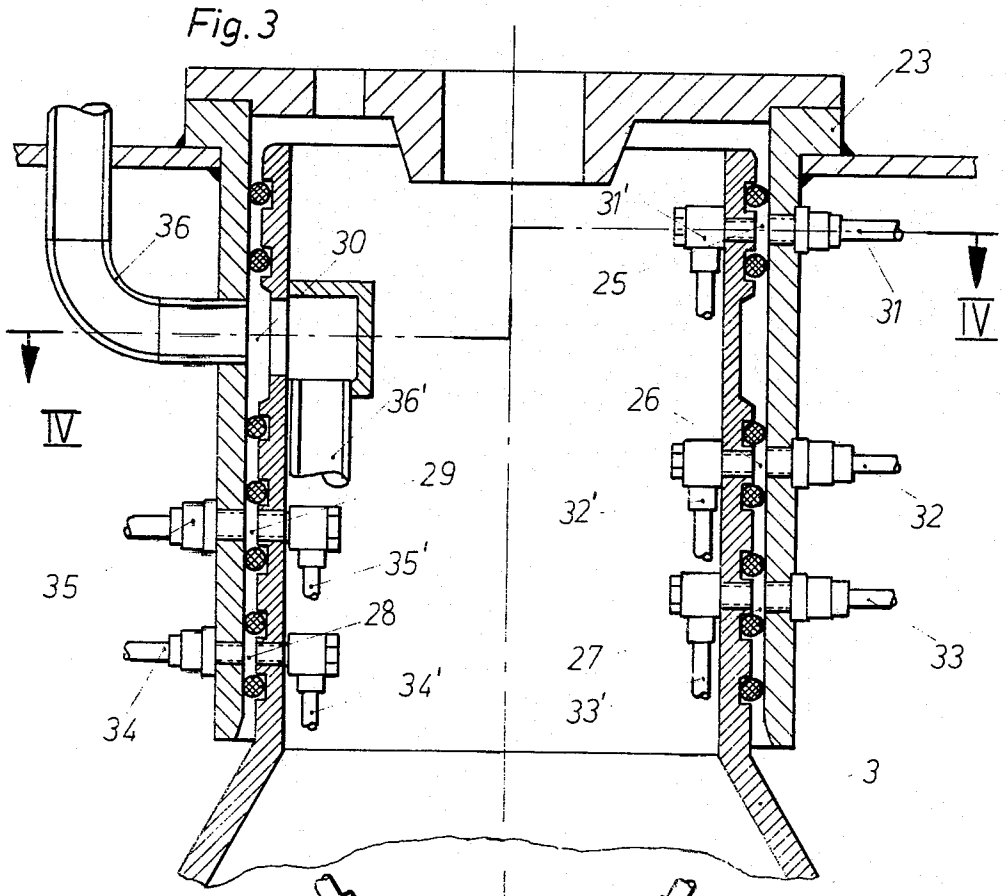
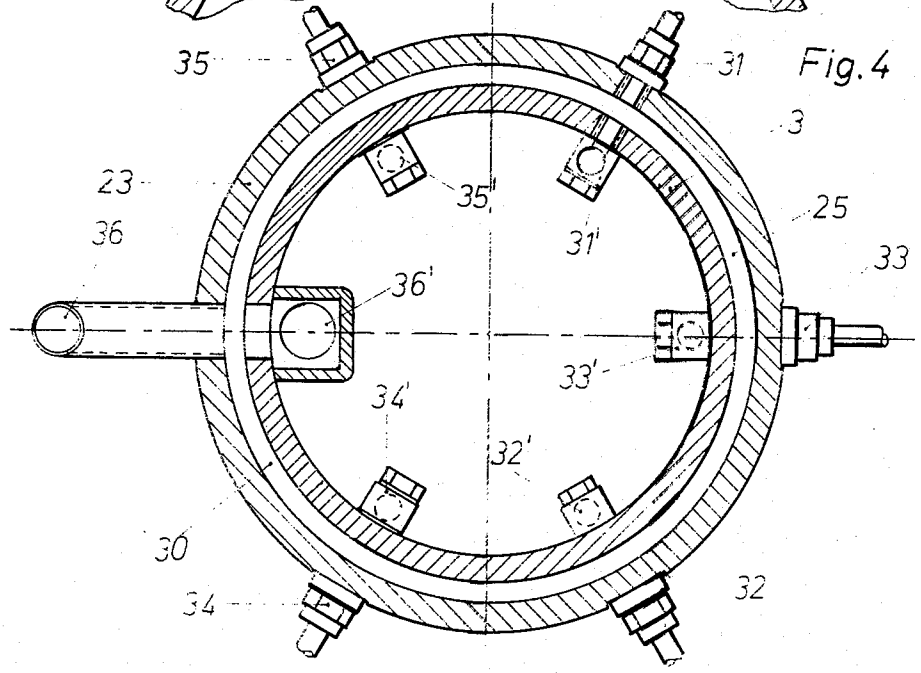

23
31'
36
30
25
31
IV
IV
36'
26
29
32'
32
35'
35
28
27
33
34'
34
33'
3

Fig. 4


35
31
3
23
35'
25
36
31'
33
36'
33'
34'
32'
30
34
32

SHIP PROPULSION UNIT HAVING A VARIABLE PITCH PROPELLER

The present invention relates to a ship propulsion unit having a variable pitch propeller supported in a hub mounted on a hollow member such that both the hollow member and hub are pivotable about a vertical axis, more particularly, to the control and operation of the propeller and associated components through a plurality of hydraulic systems.

It is known to construct a ship propulsion unit wherein the propeller is mounted upon a hub which is pivotable about a vertical axis. Such propellers have been generally referred to as pivotable propellers and are advantageous in that it is possible to precisely direct thrust from the propeller in any desired direction. In order to provide an infinite variation or adjustment of the magnitude of the thrust it is known to provide variable pitch propellers wherein the pitch of the individual propeller blades can be precisely adjusted in order to provide a desired magnitude of propeller thrust.

A combination of these two characteristics provide what might be best described as an optimal drive for a ship. The propeller thrust can be varied infinitely with respect to both magnitude and direction while the prime mover or source of power could be operated always at a constant RPM and in the same direction of rotation. This would eliminate the necessity of providing reverse or reduction gearing.

A ship propulsion unit of the general type as described above wherein the unit is pivotable and the propeller is variable in pitch is disclosed in the German publication document 1,922,834. Varying the pitch of the conventional variable pitch propeller is achieved by hydraulic control systems in the hub. However, such hydraulic systems present difficulties in the connections between moving and stationary components because of the pivoting of the hub. In order to overcome this problem, this German publication document has disclosed a mechanical actuation device for varying the propeller pitch. This mechanical actuation device is disadvantageous in that the transmission of power by such a propulsion unit is limited and such a unit can be used only up to about 1,000 H.P. In addition, because of the mechanical transmission there are a number of components which are susceptible to possible failure.

A further disadvantage is that only a single oil filled chamber is provided for the object of lubrication in the control element. A direct lubrication of the bearings, particularly with respect to an oil retaining packing which is effective for preventing the penetration of water is not possible.

The pivotable element possesses a double bearing arrangement which is also disadvantageous since this arrangement absorbs the pushing and tilting forces acting upon the propeller but the over-all height of the propeller unit is too great because of this construction.

It is therefore the principal object of the present invention to provide a novel and improved ship propulsion unit of the general type described herein.

It is another object of the present invention to provide such a ship propulsion unit which is able to transmit very high power while the control forces for the unit can be precisely and reliably regulated.

Other objects and advantages of the present invention will be apparent upon reference to the accompanying description when taken in conjunction with the following drawings, which are exemplary, wherein;

FIG. 1 is an elevational view of a ship propulsion unit according to the present invention with the upper portion of the unit being shown in section;

FIG. 2 is a longitudinal view of the hub element of the unit of FIG. 1 but in enlarged scale;

FIG. 3 is a sectional view in enlarged scale of that portion of the unit wherein the hydraulic systems are introduced into the hollow member; and

FIG. 4 is a sectional view taken along the line IV—IV of FIG. 3.

Proceeding next to the drawings wherein like reference symbols indicate the same parts throughout the various views a specific embodiment of the present invention will be described in detail.

With particular reference to FIG. 1, the ship propulsion unit according to the present invention comprises a variable pitch propeller 2 supported upon a hub 1 which is rigidly connected to a hollow member 3 positioned vertically with respect to the ship. The hollow member 3 has a teardrop or streamline cross-section to reduce hydraulic flow resistance upon the propulsion unit.

The propeller is driven by two bevel gear stages 4 and 5 that are generally arranged in the form of a Z as will be apparent from a study of FIGS. 1 and 2. A drive shaft 6 is mounted coaxially within the hollow member 3 and drivingly connects the bevel gear stages. The shaft is provided with an insertion coupling 7 which eliminates bending forces acting upon the gearing and also facilitates the disassembly of the propeller. The insertion coupling is readily engaged and disengaged by suitable movement in an axial direction and may be constructed in a form of a gear coupling, a splined clutch, a bolt clutch or the like as known in the art.

The hollow member 3 is mounted within the hull of the ship by being supported by an anti-friction ball or anti-friction tapered roller bearing 8 which functions to absorb shearing and tilting forces. With this overhanging support such forces can be reliably controlled and transmitted to the hull of the ship. The anti-friction bearing 8 has an inner race 13 which is formed by an internal ring gear 9 which is attached to the upper end or outwardly tapering portion of the hollow member 3. This construction of the inner bearing race not only reduces the costs of the installation but simplifies the structure. The hollow member 3 together with the hub 1 are pivoted by means of a spur gear 10 which meshes with the internal gear 9 and is driven by a suitable motor as known in the art but not illustrated in the drawings.

The blades of the propeller are indicated at 11 and are adjusted with respect to pitch hydraulically by means of a piston rod 12. The operative connection between the rod 12 and the blades 11 is known in the art. Such a structure may comprise a displaceable cross element connected to the piston rod and coupling rods engaging the cross element. A servo motor 15 is provided for displacing the piston rod 12 and is positioned between propeller bearings 16*a* and 16*b* for the purpose of reducing the total length of the hub 1. The pressure fluid, which may be hydraulic fluid for the servo motor 15, is controlled by an auxiliary fluid pressure motor 17 having a cylinder from which extends a piston rod operatively connected by linkage 37 to a control pin 18.

The oil level in the hub 1 is always maintained constant by a pump 19 which draws the oil from the hub 1 through a suction tube 36' and allows the oil to flow through the various lubrication points back into the hub.

In order to prevent the penetration of water into the hub 1 an oil retaining packing 20 is provided for the propeller shaft. The internal pressure on packing 20, which is higher than the external pressure, is provided by an oil gravity tank 21 connected to the pressure of the lubricating oil and is located above the water line. Oil is introduced to the packing through the line 31'.

The connection of the several hydraulic systems from the fixed housing to the pivotable hollow member 3 may be seen in FIGS. 3 and 4 and the lines of the separate hydraulic systems are shown in FIG. 3 as being slightly shifted for the purpose of clarifying the invention. The peripheral relationship of the lines may be seen in FIG. 4. A plurality of sealing rings 24 are positioned in pairs between the pivotable hollow member 3 and fixed housing 23 such that a pair of sealing rings 24 forms a number of annular chambers 25–30. The individual hydraulic systems can be connected through these annular chambers into the hub 1 independently of the position of the hollow member 3. An oil supply line 31 for the packing 20 connects from fixed housing 23 into annular chamber 25 and the inner portion of this line indicated as 31' then continues in the interior of the hollow member 3.

Lubricating oil is introduced in the same manner through a lubricating oil line 32 into annular chamber 26 and then supplied through inner line 32' as may be desired. The control fluid or oil for the auxiliary cylinder 17 is supplied through a supply line 33 into annular chamber 27 and the oil is returned from the cylinder 17 through return line 34 through annular chamber 28.

The oil for servo motor 15 is supplied through line 35 and annular chamber 29 and then through inner line 35' which connects directly to the servo motor. Pump 19 is connected through a suction tube 36, annular chamber 30 and a suction tube 36' to the oil bath or sump in hub 1.

The functions and operation of the individual hydraulic systems is described as follows:

The oil line 31' terminates at the propeller shaft packing 20 and enables the oil retaining packing to prevent the penetration of water at this point. The auxiliary cylinder 17 is actuated through supply line 33' and return line 34'. The actuation of the cylinder operates linkage 37 which controls the oil lines 38 and 39 to control the oil to the chambers 43 and 44 on both sides of the servo motor or piston 15. The oil for the servo motor 15 as controlled by the auxiliary cylinder 17 is introduced into the desired chamber of the servo motor through oil line 35', bores 40 and 41 and a recess 42 in the control pin 18. The left end of bore 40 is plugged with respect to bore 46 after the manufacturing operation of boring bore 40 through pin 18. Depending upon which chamber of the servo motor 15 is subjected to the oil under pressure, the piston rod 12 is displaced forwardly or rearwardly to effect an adjustment of the pitch of the blades 11.

The two chambers 43 and 44 of the servo motor 15 are emptied in a suitable position of the control pin 18 through an annular chamber 45 located between the control pin 18 and piston rod 12 and through bores 46, 47 into the lower portion of the hub 1. The control pin 18 is so constructed that during filling of the chamber 43 through line 38 the chamber 44 is emptied simultaneously through line 39 and bores 46 and 47.

In order to reverse the direction of movement of the piston rod 12, the chamber 43 is emptied in the same manner through line 38 into annular chamber 45 and chamber 44 is supplied simultaneously with oil under pressure. The oil level in the hub is maintained constant by the suction tube 36' which opens close to the bottom of the hub 1 as may be seen in FIG. 2.

Lubricating oil is supplied to propeller bearings 16*a* and 16*b* through lubricating oil ine 32' that further divides into lines 32*line ' and 32b'*. If desired, the lubricating oil line 32' can be further subdivided into branch lines for lubricating additional bearing points.

The propulsion unit can be readily mounted and removed because of the axial insertion coupling 7 that divides drive shaft 6 into two separate components. After loosening connecting bolts 48, the hollow member 3 together with hub 1 and propeller 2 can be removed in a downward direction as viewed in FIG. 1. The upper portion of the propulsion unit together with spur gear 10 is lifted upwardly in the same manner after bolts 49 are loosened.

In addition to the control of the pitch of the blades through the servo motor there is provided a pretensioned coil spring 50 which functions to place the propeller blades in a predetermined pitch in the event the servo motor pressure should fail. The adjusting of the blades to such a pitch insures that the ship is still maneuverable and can probably be guided to a port with the blades at a small pitch.

The propulsion unit and hydraulic connections according to the present invention is advantageous in that the unit can transmit power up to and above 30,000 H.P. The entire drive possesses relatively few moving parts and consequently is less susceptible to mechanical failure. The hydraulic system connections as disclosed herein enable the hollow supporting member together with the hub to be pivoted as a unit as desired without any necessity of providing abutment or other means for limiting movement. Depending upon the number of sealing rings provided in accordance with the present invention any number of hydraulic lines can be introduced into the hub.

It is apparent that the several lines of the hydraulic systems could possibly be connected by providing bores in the interior of the drive shaft. However, this would have the disadvantage of limiting the number of hydraulic lines and would significantly weaken the torsional strength of the drive shaft.

The overhanging or flying support or suspension of the hollow member and hub by the use of tapered anti-friction roller bearings is also advantageous since this structure considerably reduces the over-all size and weight of the installation.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

What is claimed is:

1. In a ship propulsion unit, the combination of a fixed housing, a vertical hollow member pivotable on said housing about a vertical axis, anti-friction bearing means in said fixed housing for supporting said hollow member therefrom in overhanging relationship to ab-

sorb axial and vertical forces, a hub mounted on said hollow member and pivotable therewith, a variable pitch propeller on said hub, means for driving said propeller comprising a drive shaft coaxially positioned within said hollow member, servo motor means within said hub for adjusting the pitch of said propeller blades, packing means between said hollow member and a portion of said housing, said packing comprising a plurality of pairs of spaced sealing rings and an annular chamber being defined between each said pair of rings, a plurality of fluid pressure systems for said propeller and servo motor means and each system comprising a supply and a return line passing through an annular chamber of said packing means, each of said supply and return lines having an outer portion connected to a said annular chamber from outside of said fixed housing and an inner portion within said hollow member and connected to the said annular chamber.

2. In a ship propulsion unit as claimed in claim **1** and an internal ring gear on the upper end of said hollow member and defining the inner race of said anti-friction bearing means, a motor having an output shaft with a spur gear thereon and said gear meshing with said ring gear so that said hollow member and hub are rotated by said motor.

3. In a ship propulsion unit as claimed in claim **1** wherein said servo motor means comprises a servo motor and a piston rod extending therefrom operatively connected to the blades of the propeller to adjust the pitch thereof, a control pin to regulate the supply of pressure medium through the hydraulic system supply line connected to said servo motor means, an auxiliary fluid pressure motor including a cylinder and a piston and said piston being connected to said control pin, a pair of supply and return lines connected to said cylinder, a suction tube extending into the bottom portion of said hub, and a pump connected to said suction tube.

* * * * *