July 9, 1957 J. H. STRANDELL 2,798,564

MECHANICAL CONTROLLABLE PITCH PROPELLER

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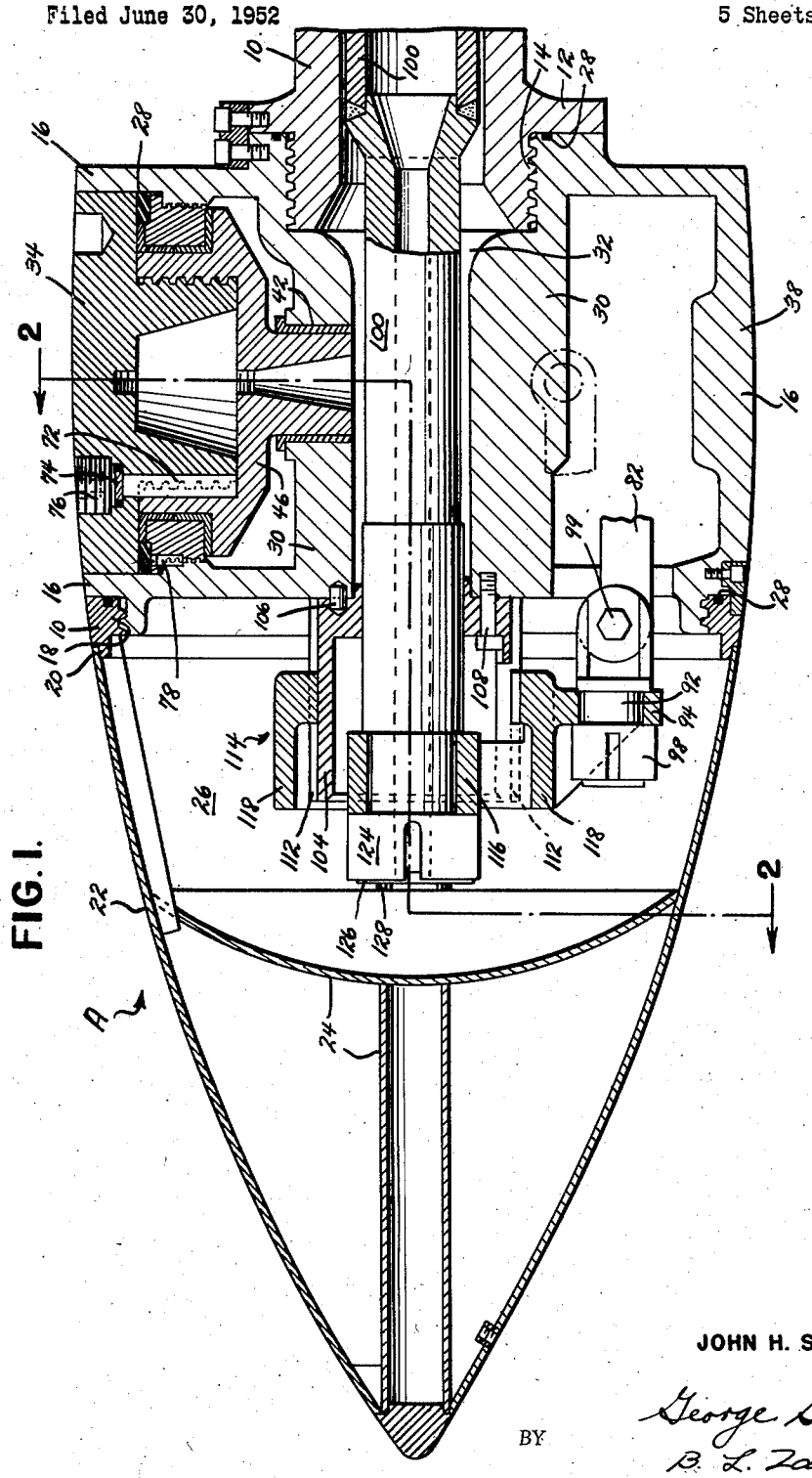


FIG. 1.

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MECHANICAL CONTROLLABLE PITCH PROPELLER

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FIG. 1-A.

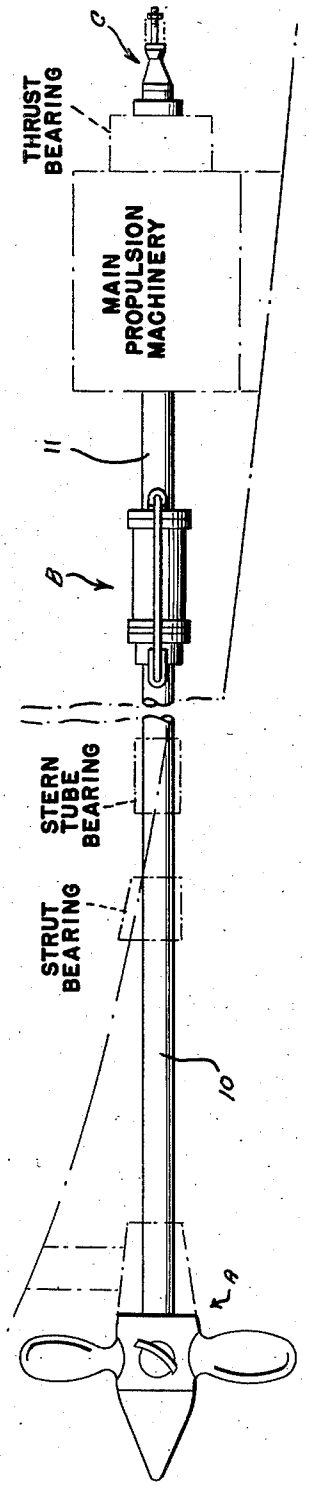
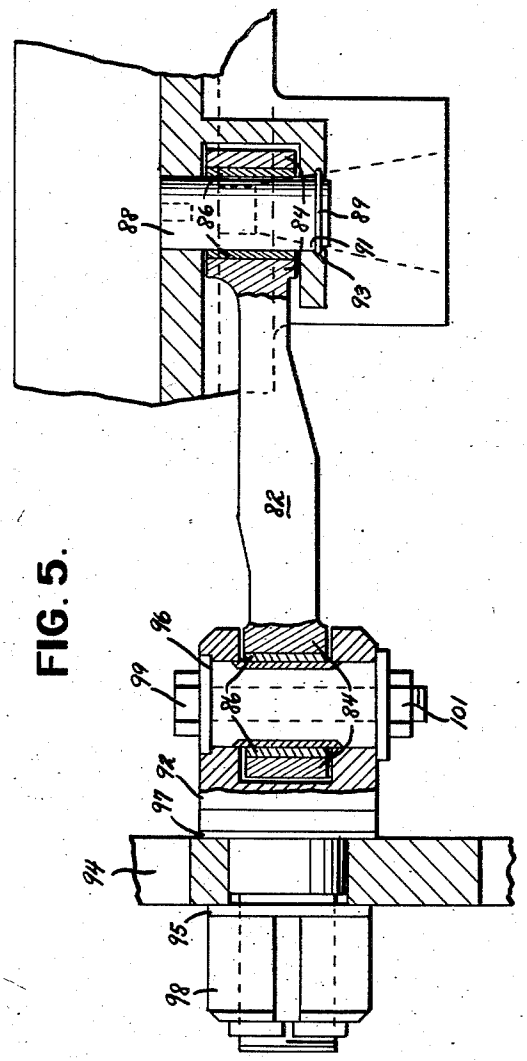



FIG. 5.




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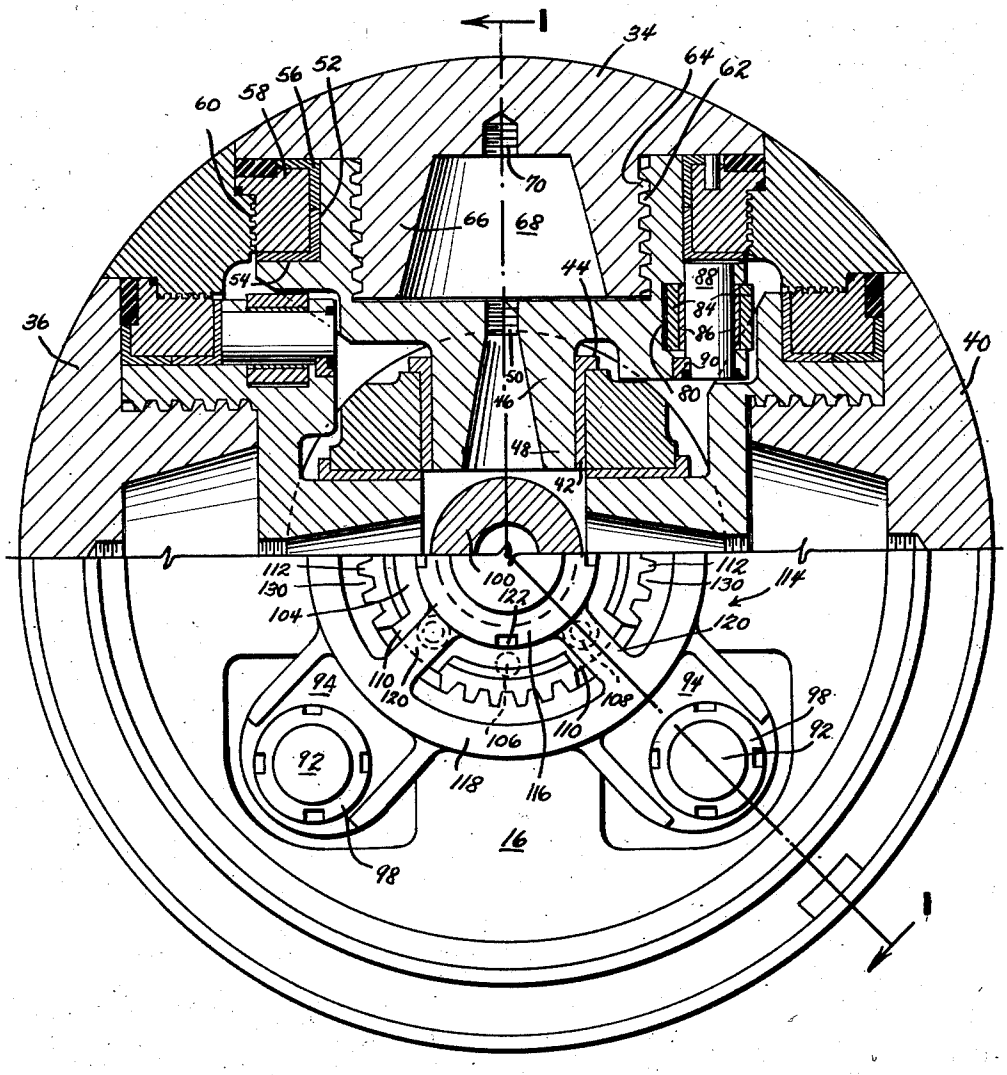
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MECHANICAL CONTROLLABLE PITCH PROPELLER

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FIG. 2.




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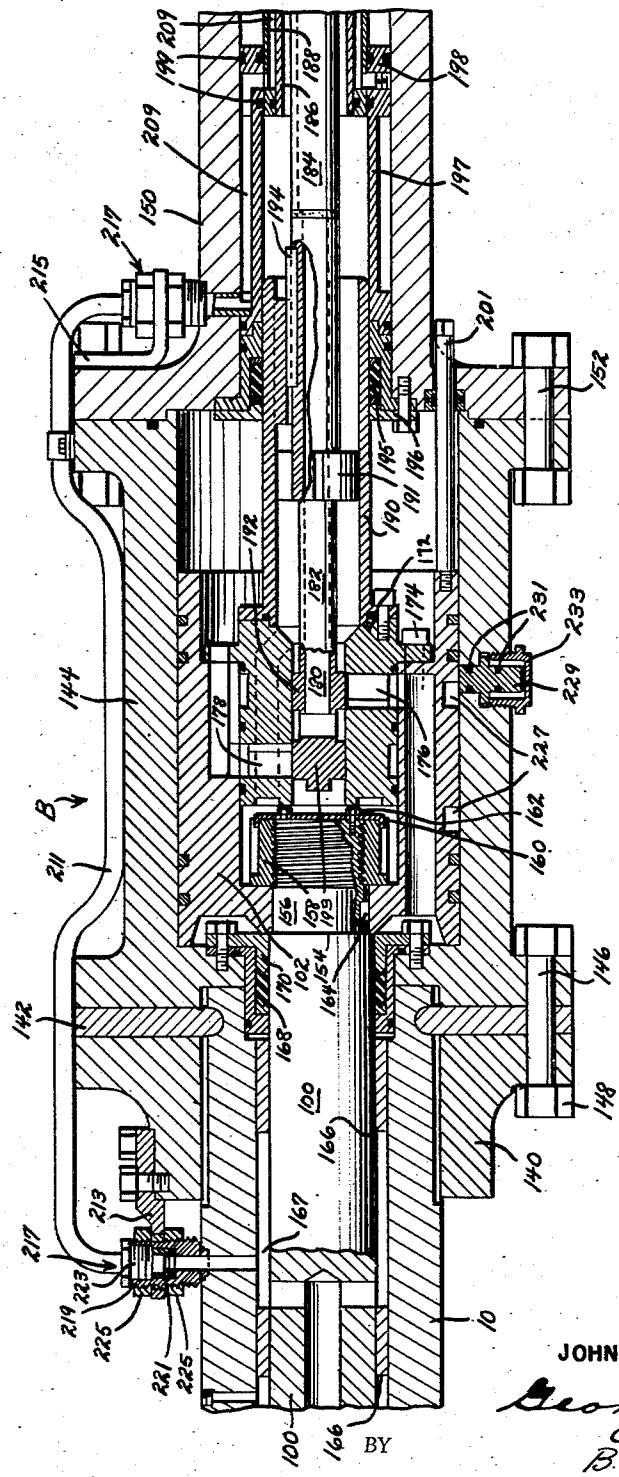
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MECHANICAL CONTROLLABLE PITCH PROPELLER

Filed June 30, 1952 5 Sheets-Sheet 4

FIG. 3.




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MECHANICAL CONTROLLABLE PITCH PROPELLER

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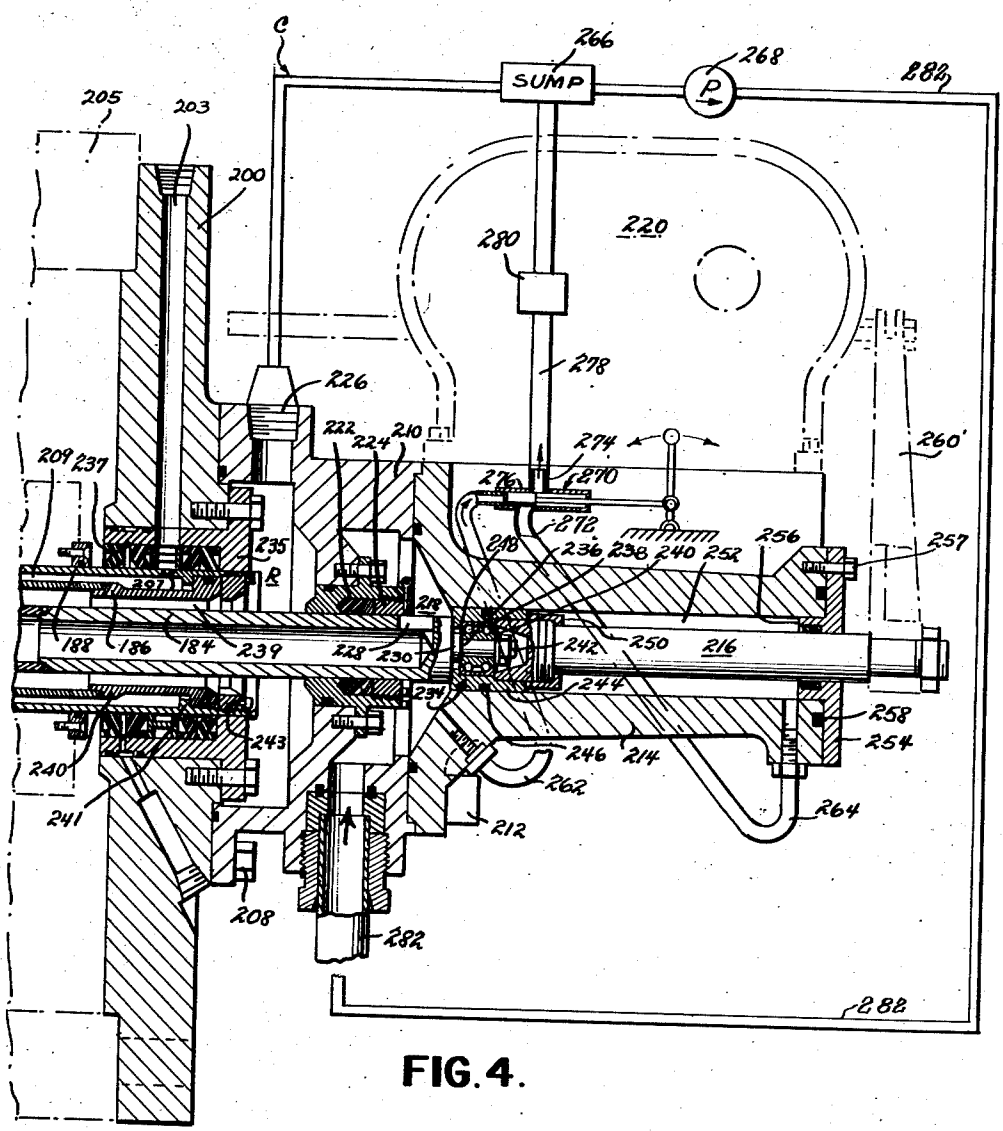



FIG. 4.

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United States Patent Office 2,798,564 Patented July 9, 1957



2,798,564

# MECHANICAL CONTROLLABLE PITCH PROPELLER

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Application June 30, 1952, Serial No. 296,515

8 Claims. (Cl. 170—160.32)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to an improvement in controllable pitch propellers, such as used on ships, having blades which can be angularly adjusted in pitch from a remote point while the ship is water borne. The blades are mounted on the propeller shaft hub and are simultaneously rotated about their own axis to achieve a change in pitch by a servo-motor mounted adjacent to the hub body, the servo-motor being responsive to a hydraulic power source located inside of the ship. The prior art discloses controllable pitch propellers of this general design but they are subject to many inherent disadvantages such as uneven and excessive wear on blade bearing surfaces, leaky hubs, improper hub lubrication, lack of positive means for moving the blades to a forward pitch position in the event of a casualty to the blade moving means, etc. It is these deficiencies that have been corrected or eliminated by the present invention, culminating several years of research and testing of experimental models installed in operating ships.

It is therefore an object of the invention to provide an improved controllable pitch propeller suitable for use on marine vessels.

A further object of the invention is the provision of a blade-actuating means actuating a servo-motor for actuating the propeller blades.

Another object is the provision of a mechanism for changing the pitch of the blades which comprises a guide arm connected to each of the propeller blades and responsive to the servo-motor mechanism.

A still further object of the invention is to provide a positive locking means for holding the propeller blades in a forward pitch position when the blade actuating means is inoperative.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description, when considered in connection with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof and wherein:

Figure 1 is a sectional view in elevation longitudinally of the propeller hub and taken on the lines 1—1 of Figure 2.

Figure 1A is a diagrammatic view showing the relative location of the elements comprising the instant invention as applied on a ship.

Figure 2 is a sectional view in elevation of the propeller hub taken on the lines 2—2 of Figure 1.

Figure 3 is a longitudinal sectional view in elevation of the servo-motor for connecting a control unit with the propeller hub.

Figure 4 is a sectional view in elevation of the control unit used for supplying hydraulic power to the servo-motor.

Figure 5 is a detailed diagrammatic view of a connecting rod showing its connections to a guide arm and crank pin ring.

Referring now to the drawings, wherein like reference characters denote like or corresponding parts throughout the several views, there is shown in Figure 1A a propeller hub A having at its forward end a propeller shaft 10 extending forwardly through a strut and stern tube bearing to a servo-motor B, which in turn connects by means of a line or propulsion shaft 11 and propulsion machinery to the control unit C shown in Figure 4.

Referring to hub A, shown in Figures 1 and 2, it will be seen that the shaft 10 flares outwardly at 12 and is provided on its after end with threads 14 which secure said shaft to hub casting 16. A circular spacer ring 18 threadably secured to hub casting 16 has a beveled edge 20 for receiving the forward end of a streamlined dunce cap 22 which is suitably strengthened at 24 and providing, in part, an opening 26 which is adapted to receive the hub moving parts for changing the pitch to the propeller blades. These members forming the hub body are snugly fitted to one another so as to form a watertight fit thus preventing entry of water into or the escape of oil from the hub, since the latter is adapted to be filled with oil under pressure at all times. In such cases where the parts cannot form such a watertight fit, circular rubber seals are provided as shown at 28, for example.

The blade holding hub casting 16 has 4 circular openings equidistantly spaced and extending around its periphery, the diameter of each being sufficiently large to accommodate a propeller blade and its associated parts for securing the blade to casting 16. The structural members of the hub casting for forming said circular openings are indicated at 30 and provide the casting with the strength for supporting the blades. In addition to the equidistantly spaced openings around the periphery of the hub, the hub also contains a longitudinal opening 32, centrally positioned in the hub. The propeller blades are respectively indicated at 34, 36, 38 and 40 and since each part employed for holding the blades to the hub casting is exactly the same, description of only one of such blades and its associated parts will be given, with the same reference characters being used to denote like parts throughout the corresponding views.

Positioned deep in casting 16 is a bearing member 42 adapted to fit into the circular opening of said casting for taking in part, the thrust exerted by blade 34. This bearing member 42 has a flange 44 extending outwardly and at the top of the bearing for properly positioning said bearing in the casting opening. Rotatively mounted within said bearing is a crank pin ring 46 formed in the shape of a cup having a neck 48 extending downwardly from the bottom of the cup which is adapted to fit in bearing 42, this crank pin ring serving the function of securing the blade to the propeller hub. The neck 48 is hollow and has a screw threaded opening 50 at its upper end for receiving a crank pin ring puller when it is necessary to remove said crank pin ring from the bearing and hub casting for repairs. The outer upper peripheral portion of crank pin ring 46 is cut away forming a vertical wall 52 and a horizontal seat 54 for receiving bearing number 56 which may be integral in construction or formed in two parts as shown in Figure 2. Bearing 56 takes the thrust exerted by blade 34 and is held in rigid position between casting 16 and crank pin ring 46 by means of ring 58 which is circular and screw threaded as shown at 60.

It is to be understood that there are sixteen bearing surfaces for the four propeller blades, or four for each blade,

They are the inner cylindrical bearing appearing at the point of contact of the outer peripheral portion of crank pin ring neck **48** with the inner surface of bearing member **42**; the outer cylindrical bearing appearing at the point of contact of crank pin ring **46** with the inner portions of bearing members or bushings **56**; the inner thrust bearing appearing at the point of contact of horizontal seat **54** with the bottom portion of lower bushing **56**; and the outer thrust bearing appearing at the point of contact of the blade flange with top portion of upper bushing **56**. The purpose of this proper blade bearing arrangement is to give the best possible distribution of the extremely large bearing forces in the space available in the relatively small hub casting. During the blade turning moment or reversing period of the propeller, the following large forces are acting on the bearings: The inner and outer cylindrical bearings are subjected to radial load caused by the following:

(*a*) Propeller thrust and torque.

(*b*) The radial load caused by the centrifugal couple due to the centrifugal force of the propeller blade itself when rotating.

(*c*) The forces from the connecting rods turning the crank arms consisting of the reaction forces, large frictional forces and dynamic forces.

The inner thrust bearing takes the thrust caused by the centrifugal force of the propeller blade assembly. It also takes the force caused by the tipping action of the propeller blade thrust and torque.

The other thrust bearing takes the reaction force caused by tipping action of the propeller blade thrust and torque.

The inner portion of cup shaped crank pin ring **46** is provided with threads **62** which are adapted to mate with similar threads **64** cut into the neck **66** of propeller blade **34**. This blade is provided with an opening **68** and has at its inner extremity a threaded portion **70** used for receiving a blade-carrying tool employed in transporting the blade from one location to another. In order to insure that the blade will not rotate out of the crank pin ring, a key and slot arrangement is provided in the blade and crank pin ring. In other words both the blade and the crank pin ring have drilled or bored thereinto a slot such as shown at **72** which align with one another to receive a key which is dropped into the mated slots and held therein by means of a plate **74** and plug **76**. A like key and slot arrangement is utilized to secure ring **58** to the hub casting. This arrangement is identical to the above-described key and slot and is generally shown at **78**.

As mentioned above, the hub A, with the attached blades **34**, **36**, **38** and **40** is rotated by the main propulsion equipment located inside the ship and in order to eliminate stopping and physically reversing the direction of rotation of the propeller shaft to secure reverse movement of the ship, the angle of pitch of the propeller blades is changed, while the hub and propeller shaft are rotating in the same direction, from an ahead to an astern pitch or, vice versa, to effect reversal in the direction of movement of the ship. Each blade is turned or rotated in its bearing by a connecting rod, connected to a guide positioned on the rearward side of the center line of the blades, which in turn receives its power from a servo-motor piston located in the servo-motor cylinder.

Referring more specifically to the drawings, it will be seen that each crank pin ring **46** has an opening **80** cut into the outer lower side of the crank pin ring. A connecting rod, one for each crank pin ring, such as indicated at **82**, has a hollow cylindrical opening integrally formed in each end thereof by walls **84**. One end of the connecting rod, Figure 5, is adapted to fit in opening **80** of crank pin ring **46** and is held therein by means of a crank pin **88**, the latter being fixed in place by a snap ring **89** which engages a shoulder **91** on the lower part of the pin after it is snapped into position in opening **93** provided in the crank pin ring. A connecting rod bushing **86** is fitted



within the opening provided by walls **84** and surrounds crank pin **88**, as is customary in connecting rod installations. The other end of connecting rod **82** is connected to guide arm **94** by means of a jaw bolt **92** which is secured to the guide arm by washer **95** and nut **98**. Pitch adjusting shims **97** are employed for properly fixing the distance between the guide arm and the crank pin ring. This end of the connecting rod is likewise equipped with a bushing **86** and is inserted in an opening provided in the jaw bolt **92** and held in place by a wrist pin **96**, bolt **99** and nut **101**.

Positioned within the aforementioned central hollow opening of the hub castnig **16** is a control rod **100** which is caused to reciprocate by a servo-motor piston **102** located in servo-motor B. A guide **104** is positioned and secured to the after end of hub casting **16** by means of dowels **106** and bolts **108**. This guide is circular and is provided with four equally spaced openings at 90° intervals, two of such openings being shown at **110**, Figure 2, and the sectors made by such openings are grooved or cut to present a plurality of gear-shaped teeth **112** which serves as a bearing for guide spider **114**. The guide spider **114** comprises two concentric rings **116** and **118** approximately secured to one another by connecting braces **120** which are aligned with openings **110** in guide **104**. The inner concentric ring **116** and the after end of rod **100** are slotted and keyed together by key **122** when guide spider **114** is positioned on rod **100**, said guide spider being held thereon by a nut **124** which is locked to rod **100** by a lock washer **126** and bolts **128**. The outer concentric ring **118** contains a section of gear-shaped teeth **130** which are adapted to mate with teeth **112** so that guide spider **114** will be required to assume a fixed position with respect to guide **104**. Extending outwardly from the outer ring **118** are four guide spider arms, equally spaced at 90° intervals, two of same being shown at **94** and **94**, which receive the after ends of connecting rods, such as that indicated by **82** and described above.

A summary of the above-described structure indicates that guide spider **114**, with its four integral, outwardly extending arms is secured to the after end of control rod **100** by nut **124**, the guide spider being set in a fixed position because of the cooperating effect with guide **104**, of mating teeth **112** and **130** and key **122**. There are four connecting rods **82**, each of said rods being secured at one end to its respective guide spider arm, such as **94**, and at its other end to its respective crank pin ring. In operation, when an ahead pitch on the propeller blades is desired, control rod **100** is moved in a forward direction carrying with its the attached guide spider **114**. Since the connecting rods are connected between the guide spider arms and crank pin rings, movement of the control rod imparts a force through the guide spider, connecting rods and crank pin rings, to move the blades counter-clockwise to an ahead pitch position. When a reverse pitch is desired, the control rod is moved rearwardly and the guide spider, connecting rods, crank pin rings and blades are accordingly moved in an opposite direction to achieve a reverse pitch on the blades.

Movement of control rod **100** is caused by servo-motor B shown in Figure 3. The servo-motor comprises a coupling sleeve **140** surrounding propeller shaft **10** and secured thereto by thrust plates **142** and to the servo-motor cylinder **144** by a plurality of bolts **146** and nuts **148**. A stub shaft **150** extending rearwardly from the main propulsion machinery is likewise secured to the servo-motor cylinder **144** by a like set of bolts and nuts **152**. A servo-motor piston **102** is appropriately positioned within the servo-motor cylinder and is provided with a control bore for receiving the forward end of control rod **100**. The control rod has a shoulder **154** cut into its forward end thus forming a reduced portion **156** which is externally threaded to receive a control rod nut **158** threaded thereon and secured thereto by a locking plate

160 and bolts 162. The nut 158 thus secures the after end of the piston to the control rod and relative rotary movement therebetween is prevented because of key 164 which locks the two together. The control rod is spaced from the inner walls of shaft 10 by bushings 166 to form an oil passage 167 and packing means 168, held in place by a plate 170, forms an oil tight fit between shaft 10 and control rod 100 to prevent the escape of high pressure oil from the servo-motor cylinder and oil passage 167.

A control valve body 172 is secured to the forward end of said piston by bolts 174 and is provided with passageways 176 and 178 which respectively communicate between the forward and after open ends of said piston and an oil supply passage 180 in control rod valve stem 182.

Referring to the right side of Figure 3, there is shown the inner tube 184, which is an extension of valve stem 182, an intermediate tube 186 and an outer tube 188. The inner tube is positioned inside of a piston guide sleeve 190 by bushing 191 and terminates in valve stem 182 having two valve lands 192 and 193 secured to the after end thereof. The inner tube 184 is secured to piston guide sleeve 190 by a key 194 and the escape of oil from the servo-motor cylinder through the space formed by line shaft 150 and piston guide sleeve 190 is prevented by packing means 195 secured in said space by a plate and bolts 196. An adapted sleeve 197 presses at one end against packing 195 and is secured at its other end to intermediate tube 186. Outer tube 188 is fixed at its after end to a ring 198 fitted with the line shaft and O-type sealing rings 199 are provided at the termination of each of the outer and intermediate tubes so as to restrict the oil in the passages formed by such tubes. A pitch indicator rod 201 is secured to the forward end of the servo-motor piston and extends forwardly through the after wall of line shaft 150 and any appropriate means such as a scale and pointer may be attached to said rod for indicating the pitch of the blades.

The hub A, in this particular modification, is adapted to be operated under an oil pressure of from 3 to 5 p. s. i., although pressures greater or less than these may be used, and the means for providing such oil pressure consists in an oil supply inlet 203 bored into the forward end of a thrust plate 200 of main thrust bearing 205. Inlet 203 communicates with opening 207 provided in outer tube 188 and extends to passageway 209 formed by the space provided between intermediate and outer tubes 186 and 188 respectively. Passageway 209 leads rearwardly to the servo-motor and is by-passed around said servo-motor by means of by-pass tube 211. Each end of tube 211 is respectively secured to the servo-motor assembly by means of brackets 213 and 215 and tube adapters 217 are connected at one end to the propelling shafts and at their other ends to tube 211. Each of shafts 10 and 150 are appropriately bored to connect passageways 167 and 209 with tube 211 so that the oil supply to hub A is provided through passageway 209, tube 211 and passageway 167 to the hub body. Both tube adapters 217 are identical so description of only one of said adapters is given herein: The adapter comprises an exteriorly threaded nipple 219 adapted to be screwed into each of the shafts. Positioned within the nipple is a rubber seal and end piece 221 which are held in place by gland nut 223. Bracket 213 surrounds the nipple at its midpoint and the nipple is secured thereto by means of nuts 225.

In the event that the main hydraulic system for supplying high pressure oil to the servo-motor piston becomes inoperative, the servo-motor piston can be normally jacked to either an ahead or astern position by a hand pump, as is customary on ships having hydraulic systems. In order to lock the piston, and therefore the propeller blades indirectly connected thereto, in a fixed position, the piston is provided with two grooves 227 which are cut to substantially the same diameter as pitch locking pin 229. This pin has a short and long end, each being provided around its periphery with O-type packing rings



231 to prevent entry of water into the servo-motor body. In normal operation, the short end of the pin is positioned in the opening provided therefor in the servo-motor cylinder walls and held in place by cap 233. When a casualty does occur, the piston is jacked to either an ahead or reverse pitch position until one of openings 227 aligns with the opening in the cylinder wall. The long end of plug 229 is then fitted into one of such openings 227 and cap 233 replaced thus locking the piston in a fixed position.

Referring now to the differential servo-motor mechanism indicated by C in Figure 4, there is shown the stationary thrust plate 200 comprising a part of a Kingsbury thrust bearing used for taking the thrust developed by the propeller blades. The stub or line shaft 150 is attached to the after end of a bull gear (not shown) located in the main propulsion machinery shown in Figure 1. As is obvious, the bull gear shaft and thrust bearing 205 are provided with a central bore for receiving the tubes 184, 186 and 188 extending forwardly in line shaft 150, and terminating adjacent the thrust bearing plate 200, as clearly shown in Figure 4. For simplicity, the details of the bull gear and thrust bearing are not illustrated on the drawing.

Plate 200 is centrally apertured to receive outer, intermediate and inner tubes 184, 186 and 188 respectively. This aperture has inserted thereinto, a packing plate 235 which is bolted to thrust bearing plate 200 and serves to hold packing 237 in position so as to prevent the oil, returning from the servo-motor in passage 239, from entering into the thrust bearing proper. Intermediate tube 186 is tied to outer tube 188 by a short connector 240, secured at one end, as by welding, to the forward end of tube 186 and is adapted to bear against a shoulder 241 of tube 188 at its other end. Ring 243 is screwed into the forward end of tube 188 and brought to bear against connector 240 thus securing the two tubes together. The tubes may be considered to float in thrust plate 200, this being necessary to allow for expansion and contraction of such tubes. Secured to the forward end of thrust bearing plate 200 is a first housing 210 which completes return passage 239 and fixed in sealed relation to said first housing 210 by bolts 212, is a second housing 214 for containing inner tube 184, said second housing forming with said first housing an oil chamber 218 for receiving oil at pressure approximating 1500 p. s. i. which is supplied to piston 102 through inner tube 184. Mounted above the second housing is a control box 220 containing the means for controlling the supply of oil to said chamber 218.

Referring more specifically to these parts, first housing 210 is centrally apertured for receiving the forward end of inner tube 184, and positioned around said tube in fluid tight relation therewith and with the first housing is a high pressure packing gland 222 secured to the first housing by the usual appropriate means including a nut 224 for taking up on the packing when it becomes worn. In the specific embodiment shown, the oil return passageway R is under a pressure of approximately 15 p. s. i. while oil chamber 218 contains pressures in the neighborhood of 1500 p. s. i., although other pressures may be used in this system, and the packing 222 serves to prevent leakage of oil from one chamber to the other. Housing 210 contains a return oil outlet at 226 for returning said oil to sump 266 for further use. The most forward end of inner tube 184 extends into oil chamber 218, which is supplied with oil by conduit 282, and has three openings in the outer end thereof, one of such openings being indicated at 228, for supplying oil through the inner tube to the servo-motor for changing the pitch of the propeller blades. Forwardly of these openings, the inner tube is sequentially reduced in diameter to form a first reduced portion 230 and a second reduced portion 232. Mounted on the second reduced portion 232 are two ball bearing races 234 comprising

inner and outer bearing shells 236 and 238 respectively, with ball bearings 240 secured therebetween. The ball bearing races 234 are held in place by a nut 242 which presses the races into engagement with the flat forward surface of first reduced portion 230, and the after end of inner tube extension 216 is hollowed out to form an opening for nut 242 and said extension is threaded on its outer exterior end. Threadably secured to said extension is a differential servo-motor piston 244 provided with oil seal rings 246 on its outer periphery and having a lip or flange 248 which aids in holding the bearing races in position. Nut 250, which forms the other end of piston 244, serves to position inner tube extension 216 in housing 214, and locks the piston 244 to said extension. The hollow central portion of second housing 214 forms with the inner tube extension 216, an oil chamber 252, which is closed at its outer or forward end by a plug 254 secured to housing 214 by bolts 257 or other similar securing means, such as screw threads or a force fit. The plug 254 is equipped with oil seal rings at 256 and 258 for preventing leakage of the high pressure oil from chamber 252 and is secured to housing 214 by bolts 257. The inner tube extension reciprocates within the plug opening and attached to the forward end thereof, is an indicating rod 260, which mechanically indicates the exact pitch to which the blades are set.

There are therefore, three oil containing chambers located in the differential servo-motor section of this invention, namely, chambers R, 218 and 252, chamber R being the low pressure return from the servo-motor to sump 266 and pump 268 while chamber 218 serves to supply oil to the servo-motor by way of the inner tube and to exert a force on differential servo-motor piston 244 for moving the inner tube in a forward direction, and chamber 252 serves to house the oil for exerting a moving force against nut 250, which in effect acts as a piston, for moving the inner tube in the after or rearward direction.

Indicated at 270 is a pilot valve having three openings thereinto, two of which are ports 272 and 274 controlled by a piston 276. Conduit 262 connects high pressure chamber 218 with the pilot valve where it transmits the oil pressure of chamber 218 to the pilot valve piston, such pressure being opposed by a heavy spring in a manner well known in the art, which keeps the piston in a balanced condition. Conduit 264 connects oil chamber 252 with the pilot valve and this conduit serves as both a supply and return for oil to said oil chamber 252, as explained hereinafter. Conduit 278 connects the pilot valve through a flow metering valve 280 to the sump 266. The means for controlling operation of pilot valve 270 is not a part of this invention but the pilot valve is controlled by electrical selsyns operated from the bridge of the ship.

In operation, with the pilot valve piston 276 blocking ports 272 and 274, constant oil pressure at 1500 p. s. i. is supplied by pump 268 to oil chamber 218 which furnishes the oil to and through inner tube 184 to the servo-motor B. This oil is further supplied through conduit 262 to pilot valve 270, conduit 264 and oil chamber 252, the latter being filled with oil at this time. When it is desired to change the pitch of the propeller blades to, say, an ahead or forward pitch position, the pilot valve piston is operated, moving it to an ahead position, uncovering port 272 and allowing the oil pressure to be transmitted through conduit 264 and chamber 252 where it acts against piston or nut 250 to move the inner tube in a backward or rearward direction, thus uncovering ports 178 in servo-motor piston to allow the oil to flow to the forward side of said piston for moving the blades to an ahead or forward pitch position. When the blades have reached the desired position, pilot valve piston 276 is then moved to recover port 272, thus blocking off the flow of oil to chamber 252 and sealing therein a complete supply of oil which continues to move piston 250 until a balance is established in the differential servo-motor. A substantial reversal of this process occurs when the propeller blades are changed to a reverse pitch position, since the pilot valve piston moves in a rearward direction and uncovers port 272, thus providing an avenue for escape of oil from chamber 252 through conduit 264, ports 272 and 274, through flow metering valve 280 to sump 266. When this occurs, the 1500 p. s. i. oil pressure in chamber 218 acts against piston member 248 to move the inner tube to a forward position. This tube action uncovers port 176 allowing oil to flow to the rearward side of servo-motor piston which moves the blades to a reverse pitch position.

It should be understood that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

What is claimed is:

1. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of said blades, said means comprising a hub casting, a guide spider having a plurality of arms extending radially therefrom, a plurality of crank pin rings, means securing said crank pin rings to said hub casting, means securing said blades in said crank pin rings, means connected to said crank pin rings at one end and to the radially extending arms at said other end, a servo-motor, a rotatable shaft connecting said servo-motor with said hub, a piston in said servo-motor, a control rod positioned in said shaft, means connecting said control rod at one end to said guide spider and at its other end to said piston, a longitudinal bore in said piston, a first passageway connecting said bore with the rearward side of said piston, a second passageway connecting said bore with the forward side of said piston, a control unit connected with said servo-motor, a differential piston in said control unit, a control valve in said piston bore for coacting with said passageways, said control valve comprising a hollow valve stem, valve lands integrally formed on one end of said valve stem, means connecting said valve stem at its other end to said differential piston, a source of fluid supply, means connecting said source of fluid supply with said differential piston in said control unit, and fluid control means moving said differential piston whereby fluid flows through said valve stem to said servo-motor piston for moving same and changing the pitch of said blades.

2. In combination, a controllable pitch propeller having blades and a hub, means for changing pitch of said blades, said means comprising a hub casting having a plurality of openings around its periphery and a central longitudinal bore therein, means securing said blades in said hub casting openings, a guide spider, a central aperture in said guide spider, a plurality of arms extending radially from said guide spider, means slidably mounting said guide spider in said hub casting and aligning said central aperture with said longitudinal bore, means respectively connecting said guide arms with said blades, a servo-motor, a rotatable shaft connecting said servo-motor with said hub, a piston in said servo-motor, said piston having a plurality of passageways for distributing pressurized fluid to the forward or after side thereof, control means in said piston controlling said passageways, a control rod connected at one end in said central aperture of said guide spider and at its other end to said piston, a control unit, a source of fluid supply, means respectively connecting said control unit to said servo-motor and said source of fluid supply, and means in said control unit for controlling the supply of said fluid to said servo-motor, whereby said fluid is diverted by said control means to either side of said piston thereby causing movement of said spider for changing the pitch of said blades.

3. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of

the blades, said means comprising a guide spider slidably attached to said hub, means for securing said blades to said hub, a plurality of connecting rods, means connecting said connecting rods at one end to said guide spider and at the other ends to said blades, a servomotor, a rotatable shaft connecting said servomotor with said hub, a piston in the cylinder of said servomotor, a hollow rod connecting said guide spider with said piston, a line shaft interconnecting the forward end of said servomotor and a thrust bearing, a control unit attached to said thrust bearing and comprising a centrally apertured thrust bearing plate, a first housing connected to said thrust bearing plate forming a first chamber, a second housing connected to said first housing forming a second chamber, a third chamber in said second housing, a differential piston in said third chamber, an inner tube in said line shaft, a hollow valve stem connected to the after end of said inner tube, valve lands on the after end of said stem for controlling passageways in said piston, means connecting the forward end of said inner tube to said differential piston, an intermediate tube surrounding said inner tube, means securing said intermediate tube at its after end to said line shaft and at its forward end to a sleeve in said thrust bearing plate, an outer tube surrounding said intermediate tube, means fixing said outer tube at its after end in said line shaft and at its forward end to said thrust bearing plate, a first passage in said inner tube, a second passage defined by the area between said inner tube and the inner walls of said intermediate tube, said second passage extending between said servomotor cylinder and said first chamber, an oil inlet in said thrust bearing plate, an opening in said outer tube adapted to be aligned with said oil inlet, an oil by-pass assembly around said servomotor, means connecting said by-pass assembly at one end to said hollow rod and at its other end to a third passageway defined by the area between said intermediate tube and said outer tube whereby oil is adapted to flow through said oil inlet, through said third passageway, said by-pass assembly and said hollow rod to said hub, an oil outlet from said first chamber, an oil inlet in said second chamber, conduit means serially connecting said outlet with a source of fluid supply and a pump to said inlet in said second chamber, means controlling supply of fluid from said fluid source to said third chamber for controlling movement of said differential piston and said inner tube connected therewith whereby fluid is caused to flow from said fluid source through said inner tube to said piston for controlling the pitch of said blades.

4. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of said blades, said means comprising a hub casting having a plurality of openings positioned around its periphery and having a longitudinal bore therein, a plurality of crank pin rings, means connecting said crank pin rings to said casting, means connecting said blades to said crank pin rings, a guide, means connecting said guide to said casting and adapted to be aligned with said bore, said guide comprising a circular member having gear-shaped teeth therein, a movable member having internally gear-shaped teeth adapted to movably slide in the teeth of said guide, means connected at one end to said movable member and at its other end to said crank pin rings, a servomotor, a hollow rotatable shaft connected at one end to said servomotor and at the other end to said hub, a piston in said servomotor, a hollow control rod positioned in said shaft connected at its after end to said movable member and at its forward end to said piston, a longitudinal bore in said piston, a first set of passageways connecting said bore with the forward side of said piston, a second set of passageways connecting said bore to the after side of said piston, valve means for controlling said passageways whereby fluid may be selectively diverted to either side of said piston for moving same and changing the pitch of said blades.

5. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of said blades, said means comprising a hub casting having a plurality of openings positioned around its periphery and having a longitudinal bore therein, a dunce cap secured to the after end of said casting, a plurality of crank pin rings, means connecting each of said crank pin rings in said openings provided in said casting, means connecting said blades to said crank pin rings, a guide, said guide comprising a hollow cylindrical member having gear-shaped teeth thereon, means securing said guide to said casting, a movable member for engaging said guide, said movable member comprising a pair of concentric rings, a set of gear-shaped teeth formed on the inner side of the outer ring adapted to mate with the outer teeth of said guide, a control rod in said longitudinal bore, means connecting said control rod at its after end to said inner ring, a plurality of radially extending arms integrally formed on said outer ring, a plurality of connecting rods, means connecting each of said connecting rods at one end to the arms of said outer ring and at their other ends to said crank pin rings whereby movement of said control rod is imparted through said arms and connecting rods to said crank pin rings for changing the pitch of the blades.

6. The combination, according to claim 5, wherein the means for securing the crank pin rings to said casting comprises a neck formed on the bottom of said crank pin ring adapted to fit into an opening provided by said casting, a bearing member separating said crank pin ring from said casting, a cut-away portion formed on the upper outer peripheral portion of said crank pin ring forming a vertical wall and horizontal seat, a second bearing member positioned on said seat, a circular ring, screw threads on the outer side of said ring, a set of threads in said casting whereby said ring is screwed into said casting thus rigidly holding said crank pin ring in said casting opening.

7. The combination according to claim 5 wherein said hub is of a watertight construction, said construction comprising a circular gasket positioned between the upper part of said ring and the lower section of said propeller blade.

8. In combination, a control unit, said control unit comprising a centrally apertured thrust bearing cover plate, three concentric tubes in said central aperture, packing means between the outer of said three tubes and said bearing plate, means securing the end of the intermediate of said three tubes to said outer tube, a first housing secured to said bearing plate and forming therewith a first chamber, an outlet from said chamber, a second housing secured to said first housing forming a second chamber, the inner of said three concentric tubes extending forwardly through said first chamber and terminating in said second chamber, packing means positioned between said inner tube and said first housing thus positively separating said second chamber from said first chamber, a longitudinal bore in said second housing connected with said second chamber, an inner tube extension positioned in said longtiudinal bore forming a third chamber between said extension and the inner walls of said bore, a differential piston connected to the end of said inner tube extension, an inlet into said second chamber, a source of fluid supply, a pump, conduit means serially connecting said outlet, said source of fluid supply, and said pump with said inlet to said second chamber, a pilot valve, a first conduit connected at one end to said second chamber and at its other end to the inlet of said pilot valve, a second conduit connected at one end to said third chamber and at its other end to said pilot valve, a third conduit connected at one end to an outlet of said pilot valve and at its other end to said source of fluid

supply whereby said pilot valve controls the fluid pressure in said third chamber for obtaining movement of said differential piston and said inner tube connected therewith.


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