# United States Patent

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[72] Inventor **Ernest Muller**
c/o Messageries-Maritimes, AMP Building, Sydney, Australia



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[54] **MARINE PROPELLER SHAFTS BEARING ARRANGEMENTS**
**13 Claims, 11 Drawing Figs.**


[52] **U.S. Cl.** ..... **115/34, 308/4**
[51] **Int. Cl.** ..... B63h/23/36
[50] **Field of Search** ..... 115/34, 37, 0.5; 308/4



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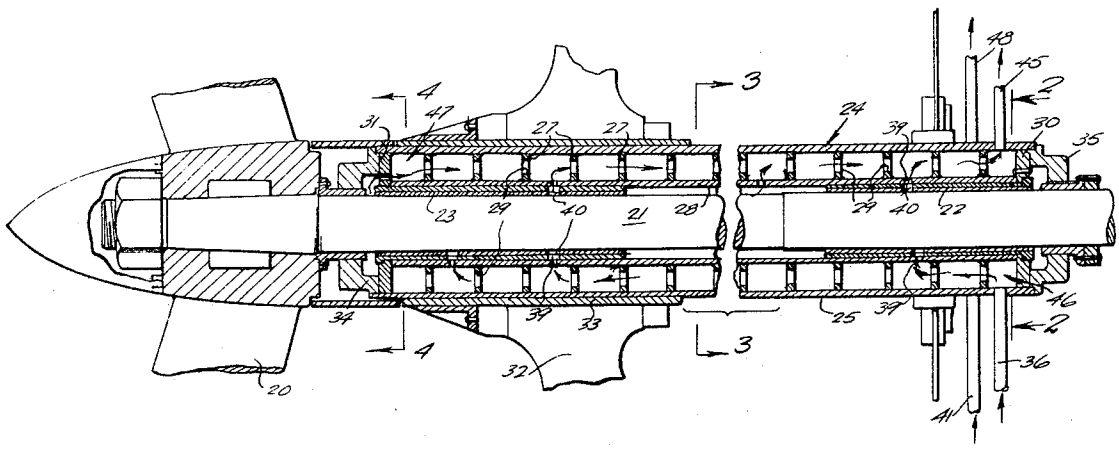
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*Primary Examiner*—Milton Buchler
*Assistant Examiner*—Carl A. Rutledge
*Attorney*—Victor J. Evans and Co.

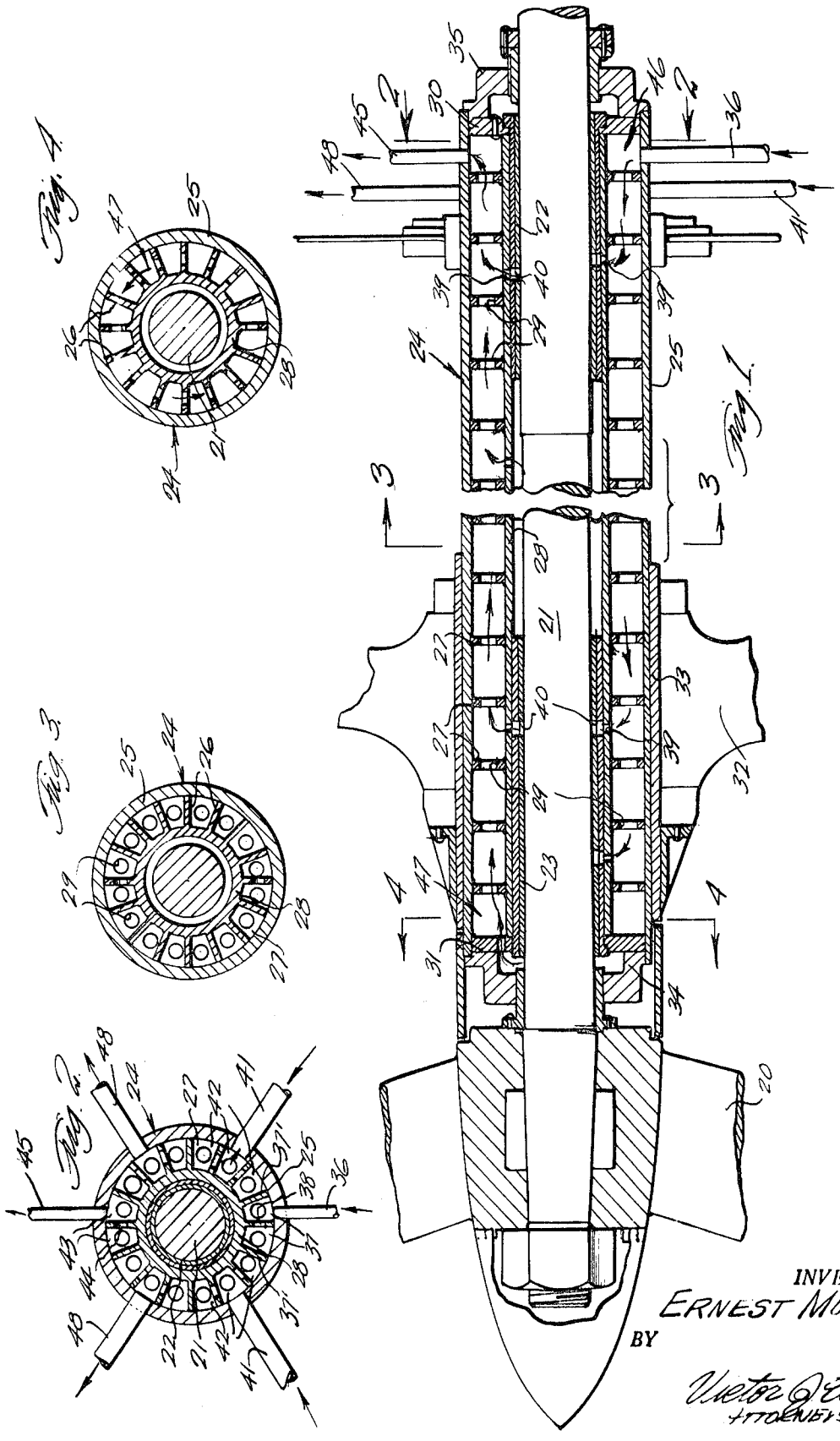


**ABSTRACT:** Marine propeller shaft bearing assemblies feature a double-walled stern tube which is extremely rigid in construction so as to be capable of resisting primary bending stresses before they can affect the shafting proper. The rigid stern tube permits extension for a considerable distance aft of the stern post of the vessel, thus enabling the positioning of propellers a more favorable distance from the hull to reduce vibration. The annular passage between the walls of the stern tube is utilized for the flow of cooling and lubricating fluids. The structure is applicable to single propeller shafts and counterrotating propeller shafts.

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INVENTOR.
ERNEST MULLER
BY
Victor J. Evans & Co
ATTORNEYS

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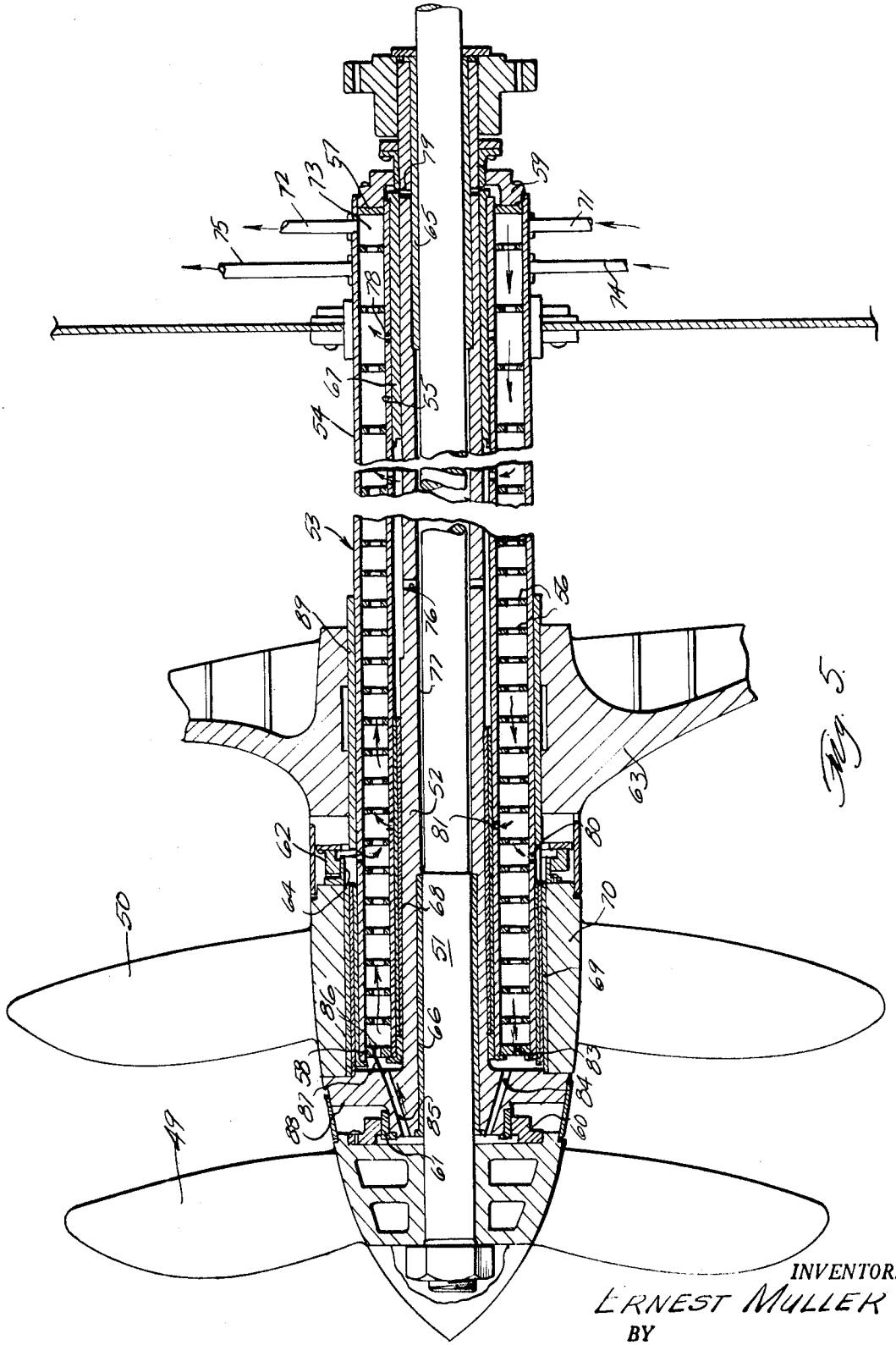


Fig. 5

INVENTOR.
ERNEST MULLER
BY
Victor J. Evans & Co
ATTORNEYS

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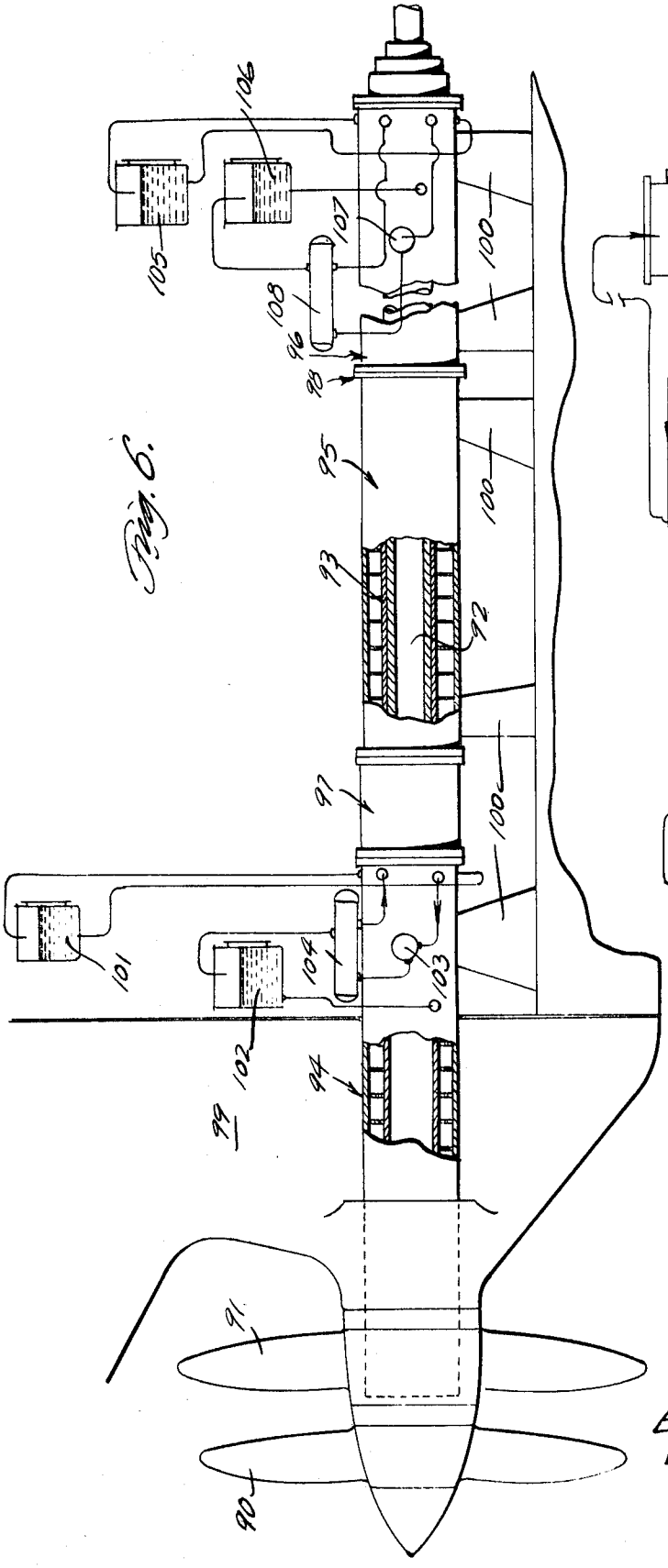



Fig. 6.

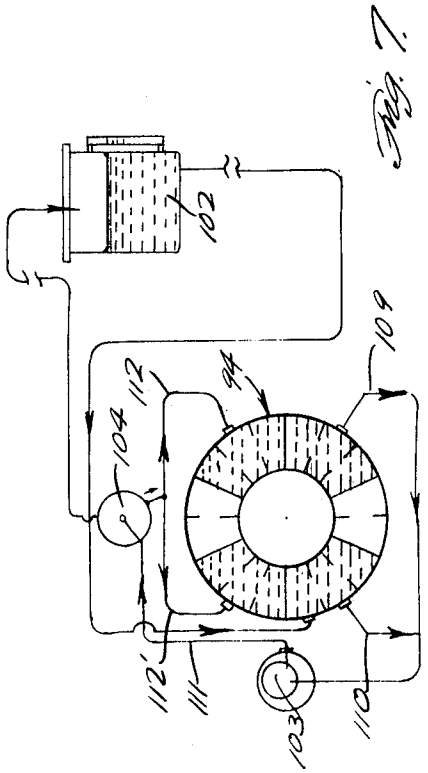



Fig. 7.

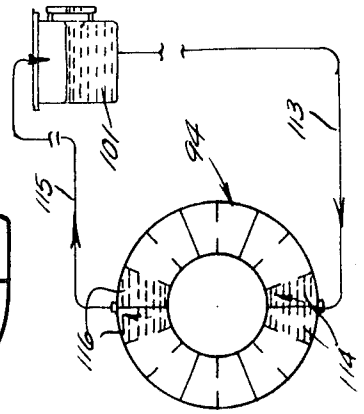



Fig. 8.

INVENTOR.
ERNEST MULLER
BY
Victor J. Evans & Co.
ATTORNEYS

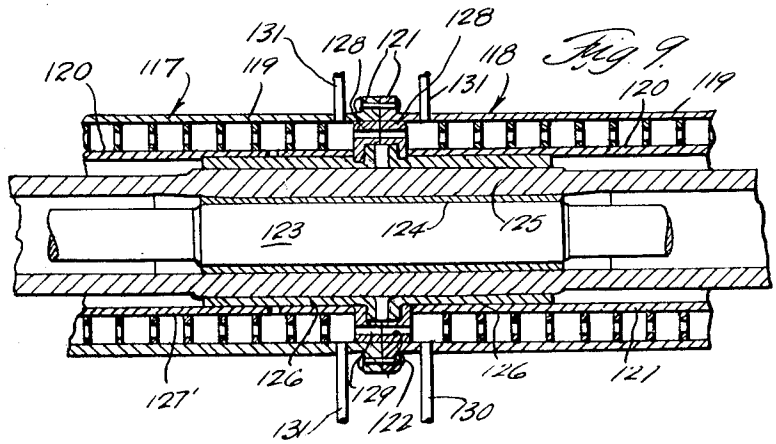



Fig. 9.

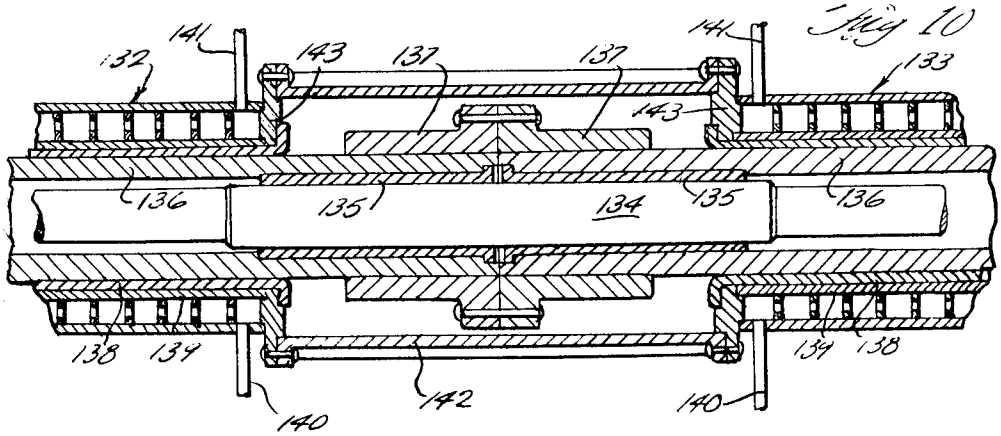



Fig. 10

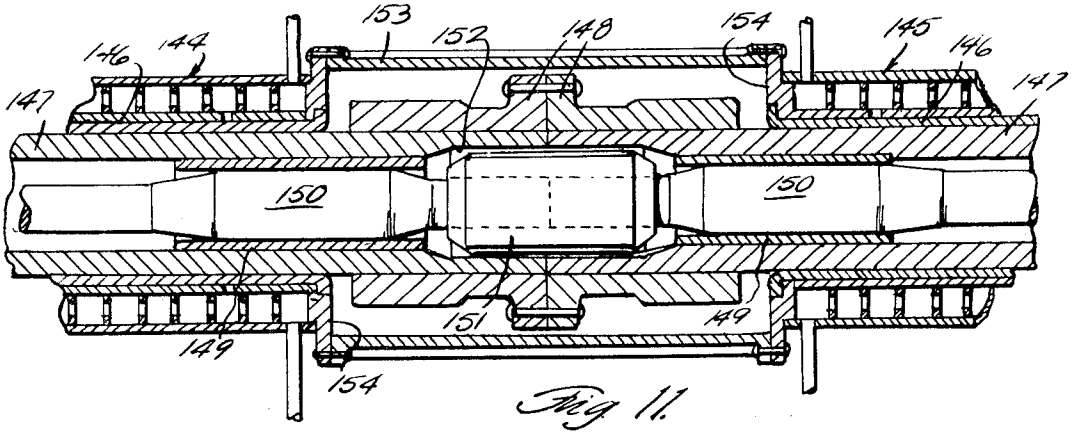



Fig. 11.

INVENTOR.
ERNEST MULLER
BY
Victor J. Evans & Co.
ATTORNEYS

# MARINE PROPELLER SHAFTS BEARING ARRANGEMENTS

## BACKGROUND OF THE INVENTION

Shipbuilding has progressed very rapidly particularly in recent years and there seems to be no limit on the sizes which can be built. In general, marine propulsion systems have kept abreast of shipbuilding progress but the design and construction of propeller shafting has not kept abreast of progress and the well-known vibration problems and inefficient lubrication of propeller shaft bearings have not been overcome.

It is therefore the objective of this invention to provide marine propeller shaft bearing and support means which will satisfy the needs of the modern-day shipbuilding industry particularly as regards rigidity and ability to cool and lubricate the shaft bearings and to enable the propellers to be located a sufficient distance aft to reduce vibration at least within tolerable limits.

The invention satisfies these needs in connection with single conventional propeller shafts with fixed or controlled pitch blades or with counterrotating propeller shafts. The heart of the invention resides in a unique double-walled stern tube which is internally stiffened both longitudinally and transversely and contains fluid passages for lubricating and cooling media which may be circulated under pressure.

Other detailed objectives and features of the invention will be apparent during the course of the following detailed description.

## DESCRIPTION OF DRAWING FIGURES

FIG. 1 is a fragmentary central vertical longitudinal section through the stern portion of a vessel having propeller shaft support means in accordance with one preferred embodiment of the invention.

FIG. 2 is a transverse vertical section taken on line 2–2 of FIG. 1.

FIG. 3 is a similar section taken on line 3–3 of FIG. 1.

FIG. 4 is a similar section taken on line 4–4 of FIG. 1.

FIG. 5 is a central vertical longitudinal section through a modified form of the invention involving counterrotating propellers and concentric propeller shafts.

FIG. 6 is a diagrammatic view of a counterrotating propeller system showing separate lubricating and cooling circuits.

FIG. 7 is a cooling oil diagram.

FIG. 8 is a lubricating oil diagram.

FIGS. 9, 10 and 11 are fragmentary longitudinal vertical sections showing connections of a stern tube in accordance with the invention with an intermediate bearing tube.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. 1 to 4 of the drawings in detail, wherein like numerals designate like parts, the numeral 20 designates a propeller conventionally coupled to propeller shaft 21 journaled in forward and aft white-metal-lined bearings 22 and 23. A stern tube assembly 24 constituting the heart of the invention comprises an outer cylindrical stern tube wall 25 shrunk over a plurality of circumferentially equidistantly spaced longitudinal stiffeners 26 and a plurality of longitudinally equidistantly spaced transverse annular stiffeners 27. The number and spacing of the longitudinal and transverse stiffeners may be varied to satisfy the required resistance to bending of the particular stern tube assembly.

The stern tube assembly further comprises an inner cylindrical wall or tube 28 spaced from and concentric with the outer wall 25 and having the stiffeners 26 and 27 welded thereto. The stiffeners 26 and 27 are also welded to one another at points of intersection. Each transverse stiffener 27 has openings 29 formed therethrough between the several longitudinal stiffeners 26 as shown in FIG. 3 and these openings collectively form a longitudinal passage for the flow of fluid through the stern tube in the space between two walls thereof, as will be further discussed in connection with lubricating and cooling. The fore and aft ends of the stern tube assembly are closed by cover plates 30 and 31, as shown in FIG. 1.



Adjacent to the stern post 32 of the vessel, the outer tube or wall 25 of the stern tube assembly 24 is reinforced by another tube section 33 shrunk over the tube 25. The stern tube assembly is rendered oiltight by means of conventional oil seals 34 and 35 at the ends thereof. The lubricating oil circuits through the stern tube are indicated by arrows in FIG. 1 and will be further discussed. Lubricating oil is fed to the stern tube interior through a lower inlet pipe 36, FIGS. 1 and 2, into two lower longitudinal passages 37 bounded by longitudinal stiffeners 37', FIG. 2, which have no openings formed therethrough, the intervening longitudinal stiffener having opening means 38. The stern tube inner wall 28 also has openings 39 formed therethrough radially in registration with like openings 40 in the two bearings 22 and 23 for the passage of lubricant.

Cooling oil enters the stern tube through a pair of lower quadrant port and starboard pipes 41 on opposite sides of the lubricating oil passages 37 and this cooling oil flows into communicating longitudinal passages 42 as shown in FIG. 2 in the two lower quadrants of the stern tube interior.

Sections through the assembly are shown in FIGS. 2, 3 and 4 and these views clearly show the lubricating and cooling circuits. Considering the stern tube from the forward end, FIG. 2, this FIG. shows the two lower interconnecting longitudinal lubricating oil passages 37 and a similar upper pair of lubricating oil passages 43 which are in communication through opening means 44. At the top of the assembly, the lubricating oil discharges from one of the passages 43 through an outlet pipe 45, also shown in FIG. 1.

At stated, cooling is maintained by two separate cooling oil circuits, one on each side of the stern tube assembly. The incoming cooling oil from pipes 41 fills the two lower quadrants from the first annular space forward indicated at 46 in FIG. 1, feeding the cooling oil through the stern tube longitudinally as shown in FIG. 3 to the after end of the stern tube shown in cross section in FIG. 4. In such after compartment 47, FIG. 1, the cooling oil turns upwardly to the two upper quadrants shown by the arrows in FIG. 4 and flows forwardly longitudinally to the upper quadrant outlet pipes 48 shown particularly in FIG. 2 and also in FIG. 1. This arrangement affords cooling over two-thirds of the bearing surface area and also affords cooling throughout the total length of the stern tube, simultaneously with the lubrication of the moving parts, as described.

FIG. 5 shows a form of the invention differing from the form shown in FIG. 1 in that counterrotating propellers 49 and 50 are coupled, respectively, to an internal solid propeller shaft 51 and a surrounding concentric tubular propeller shaft 52. The double-walled stern tube assembly 53 is constructed essentially identically to the previously described stern tube assembly 24 and includes outer and inner tubes 54 and 55, transverse annular stiffeners 56, longitudinal stiffeners and fore and aft cover plates 57 and 58. A forward oil seal 59 seals the forward end of the stern tube assembly and another oil seal 60 on the hub of propeller 49 has sealing contact with a hub element 61 or ring of tubular propeller shaft 52. Another oil seal 62 fixed to the structure of the stern post 63 seals with a ring 64 of propeller 50.

Propeller shaft 51 is journaled in fore and aft bearings 65 and 66 held within the bore of tubular shaft 52. The latter shaft 52 is journaled for rotation in fore and aft bearings 67 and 68 within the bore of the interior tube 55 of stern tube assembly 53. Another aft bearing 69 is interposed between the hub 70 of propeller 50 and the outer tube 54 of the stern tube assembly so that a total of three concentric bearings is provided aft of the stern post 63 for the support of relatively rotating parts. Again, the dual-walled stern tube, because of its great rigidity, insulates the rotary propeller shafts 51 and 52 from direct bending stresses and allows the two propellers 49 and 50 to be mounted well aft of the stern post 63 to cut vibration to the minimum.

The cooling and lubricating oil circuits in FIG. 5 are essentially similar to those described in FIGS. 1 to 4, the lubricating oil entering through a lower pipe 71 and discharging through an upper pipe 72 at the forward annular compartment 73 of the hollow stern tube assembly. The similar cooling oil inlet and outlet pipe means is indicated at 74 and 75 in FIG. 5 and the complete description of the oil circuits need not be repeated. Radial ports 76 in the tubular shaft 52 allow the entry of oil in the annular space 77 between the two concentric shafts 51 and 52. Similar radial ports 78 and 79 provide lubrication for the bearings 65 and 67 and ports 80 and 81 allow lubricating of the bearings 69 and 68. The bearing 66 obtains lubricating oil at its forward end from the passage 77.

An added feature in FIG. 5 is the provision for oil circulation into the space 82 between the propeller 49 and the aft hub end of shaft 52. Ports 83 and 84 allow inflow of oil from the stern tube to the space 82 and the oil flows out of this space and back to the stern tube through ports 85 and 86, filling the space 87 adjacent the drive coupling or hub 88.

As in the previous embodiment, the stern tube is reinforced adjacent the stern post 63 by another tube section 89.

FIG. 6 diagrammatically illustrates counterrotating propellers 90 and 91 driven respectively by concentric shafts 92 and 93 substantially as shown in FIG. 5. FIG. 6 illustrates stern tube assembly 94 constructed substantially the same as assemblies 24 and 53 and also intermediate double-walled bearing tubes 95 and 96 rigidly interconnected by couplings 97 and 98. Stern tube 94 is supported aft on the stern post 99 and forward on spaced pedestal means 100 at suitable intervals. In essence, the stern tube in FIG. 6 is formed in sections with intervening couplings to allow connections of the sections and the propeller shafting. Details of coupling means are illustrated in FIGS. 9 to 11 and will be described.

Stern tube 94 in FIG. 6 is separately lubricated through oil circuits under pressure fed by gravity tank 101. The cooling of stern tube 94 is accomplished under pressure from another tank 102 for oil and an associated circulating pump 103 and cooler 104. For the intermediate bearing tubes 95 and 96, lubricating pressure is less than required for the more critical stern tube 94. The forwardmost bearing tube 96 is however equipped with a pressure lubricating oil tank 105 similar to the tank 101 and a cooling oil tank 106 with pump means 107 and cooler 108, as indicated in FIG. 6.

FIG. 7 is an enlarged cooling oil diagram corresponding to the arrangements in FIG. 6. Circulating pump 103 in FIG. 7 draws the oil through lines 109 and 110 from the lower side compartments, port and starboard, of stern tube 94 and discharges it through a line 111 and cooler 104 into both upper side compartments of stern tube 94 through branch lines 112 and 112'. The oil makes it circuit within the stern tube 94 in the manner originally described in FIGS. 1 to 4 and finally returns to the suction side of pump 103.

FIG. 8 is a lubricating oil diagram pertaining to the stern tube 94 showing the aforementioned tank 101 having an infeed line 113 leading to the lower longitudinal oil compartments 114 and a return line 115 leading from the upper longitudinal oil compartments 116, generally in the same manner described originally in FIGS. 1 through 4.

FIG. 9 shows a coupling structure between adjacent stern tube or bearing tube sections 117 and 118, both of which have the characteristic outer and inner walls 119 and 120 and intervening transverse and longitudinal stiffeners, as described in previous embodiments. The sections 117 and 118 may consist of adjacent stern tube or bearing tube sections such as those discussed in FIG. 6. In FIG. 9, the outer walls 119 are equipped with annular flanges 121 fixedly secured in face-to-face relationship by suitable fastener elements 122. In the assembly shown, an inner propeller shaft 123 is journaled in a bearing 124 contained in a tubular propeller shaft 125, the latter shaft journaled in bearing sections 126 held within the bore of the interior tube 127 or 127' of the bearing tube sections 117 and 118. Opposed seals 128 are provided at the joint formed by the flanges 121 and these seals have lubricant ports 129 formed therethrough. Inlet and outlet tubes 130 and 131 for lubricant is provided for the two sections 117 and 118.

FIG. 10 shows another form of coupling between stern tube or bearing tube sections 132 and 133. In this assembly, an interior propeller shaft 134 is journaled within bearing sections 135 mounted within the bores of tubular propeller shaft sections 136 having couplings 137 secured to their abutting ends in fixed relationship.

The tubular shaft sections 136 in turn are journaled within sleeve bearings 138 mounted within the bores of the interior tubes 139 of double-walled stern tube sections 132 and 133. These stern tube sections are constructed in substantially the manner previously described and they are equipped with oil infeed tubes 140 and oil discharge tubes 141, as shown. An exterior coupling sleeve 142 surrounds and encloses the shaft couplings 137 and has its ends rigidly secured to flange plates 143 which also serve to close the adjacent ends of hollow stern tube sections 132 and 133.

FIG. 11 shows another form of connection or coupling between stern tube sections 144 and 145 having bearings 146 mounted therein. Tubular propeller shaft sections 147 are journaled within these bearings and are secured in end-to-end relation by external coupling heads 148 having flanges, as shown. Shaft sections 147 contain bearings 149 for solid propeller shaft sections 150 coupled by a sleeve 151, said sleeve located between the bearings 149 and within an enlargement 152 of the bores of shaft sections 147. The coupling heads 148 and associated parts are all enclosed by an outer coupling sleeve 153 having its ends secured to flange plates 154 substantially identical to the plates 143 in FIG. 10. Other similar types of couplings can be devised.

It should again be emphasized and understood that the essence of the invention resides in the provision of a dual-walled reinforced stern tube formed in one section or plural sections and providing the primary support for propeller shafting whether in the form of a single shaft or telescoped counterrotating shafts. The stern tube facilitates the effective lubrication and cooling, as described, of all important bearings and allows the propellers to be placed sufficiently aft of the stern post to reduce vibration to the very minimum.

I claim:

1. A marine propulsion shaft structure comprising a stern tube adapted to be directly mounted on the stern post of a vessel so as to form the primary support for propulsion shafting, said stern tube comprising a pair of spaced substantially concentric tubes and intervening spaced longitudinal and transverse stiffeners anchored to said tubes and imparting to the stern tube great resistance to bending, bearing means within the bore of the stern tube, propeller shaft means journaled within the bearing means for rotation and extending aft of the vessel stern post for a considerable distance, and said stern tube having internal passage means through which lubricating and cooling fluid may flow in separate circuits.

2. The structure of claim 1, and said stern tube formed in longitudinal sections, and coupling means serving to interconnect said sections whereby a relatively long stern tube and bearing tube assembly can be produced.

3. The structure of claim 1, wherein said stern tube and propeller shaft means are formed in sections, a first coupling means for the propeller shaft sections, and a second coupling means for the stern tube sections surrounding and enclosing the first-named coupling means.

4. The structure of claim 1, and said longitudinal and transverse stiffeners defining longitudinal and transverse chambers between the tubes of said stern tube, said longitudinal and transverse stiffeners having openings and said openings arranged to provide separated lubricating and cooling fluid circuits through the stern tube, and said circuits having inlet and outlet means near the opposite ends of the stern tube.

5. The structure of claim 4, and wherein said lubricating fluid circuit consists of longitudinal channels for lubricating fluid between the tubes along the top and bottom of the stern tube and said cooling fluid circuit consists of additional lon-

gitudinal channels extending along the opposite sides of the stern tube.

6. The structure of claim 1, wherein said propeller shaft means comprises a single propeller shaft journaled within the bearing means and a propeller carried by the aft end of the propeller shaft aft of the stern tube and stern post.

7. The structure of claim 1, wherein the propeller shaft means comprises a tubular propeller shaft journaled within the bearing means, a propeller coupled to the tubular shaft and rotating therewith, a second propeller shaft extending axially through and journaled within the tubular shaft, and a second propeller coupled to the second propeller shaft and turning therewith.

8. The structure of claim 7, and said propeller coupled to the tubular shaft having a hub concentric with the tubular shaft and stern tube and surrounding the exterior wall of the stern tube, and an additional bearing intervened between said hub and said exterior wall.

9. The structure of claim 8, and a coupling head interconnecting said hub and tubular shaft and lying between said propellers at the aft end of the stern tube.

10. The structure of claim 1, and closure plates for the fore and aft ends of the stern tube, and fluid seals on the propeller shaft means having sealing engagement with the closure plates.

11. A marine propulsion shaft structure comprising a stern tube adapted to be directly mounted on the stern post of a vessel so as to form the primary support for propulsion shafting, said stern tube comprising a pair of spaced substantially concentric tubes of equal length longitudinally aligned with each other and intervening spaced longitudinal and transverse annular stiffeners anchored to said tubes and imparting to the stern tube great resistance to bending, bearing means within the bore of the stern tube, propeller shaft means journaled within the bearing means for rotation and extending aft of the vessel stern post for a considerable distance, and said stern tube having internal passage means through which lubricating and cooling fluid may flow in separate circuits.

12. The structure of claim 11, and said stern tube formed in longitudinal sections, and overlapping concentric couplings interconnecting said sections whereby a relatively long stern tube and bearing tube assembly can be produced.

13. The structure of claim 12, wherein said stern tube and propeller shaft means are formed in longitudinal sections, and including coupling means for the propeller shaft sections said couplings coaxial with, having the same longitudinal midpoint as, and enclosing said coupling means.