March 4, 1969 K. R. PIKE ET AL 3,430,604

INBOARD-OUTBOARD DRIVE

Filed Jan. 24, 1967 Sheet 1 of 2

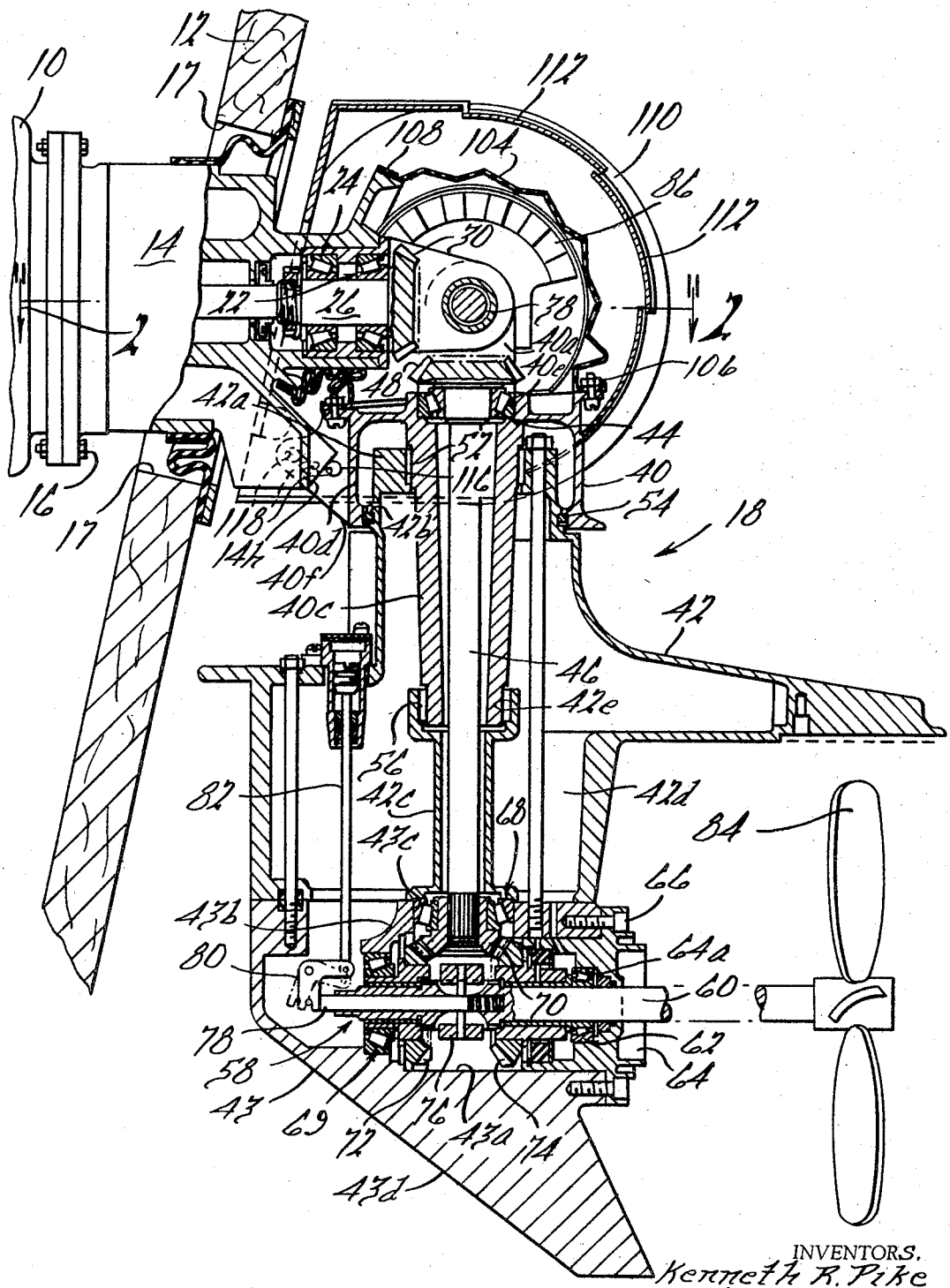


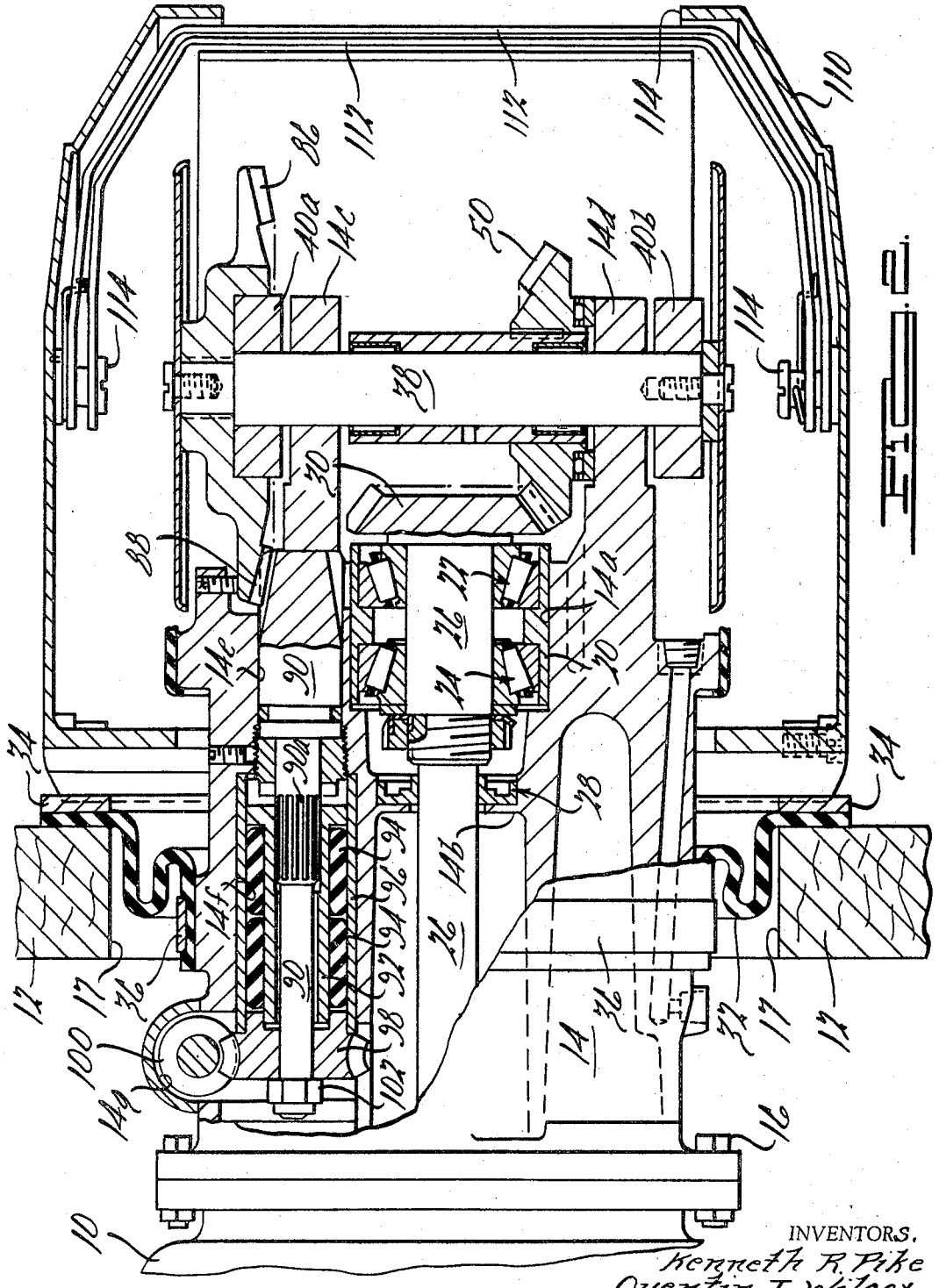
Fig. 1.

INVENTORS.
Kenneth R. Pike
Quentin I. Wilcox
Allen E. Cooper
By Harness, Dickey & Pierce
ATTORNEYS.

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INVENTORS.
Kenneth R. Pike
Quentin I. Wilcox
Allen E. Cooper
BY
Harness Dickey & Baldwin
ATTORNEYS.

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INBOARD-OUTBOARD DRIVE

Kenneth R. Pike, Hartford, Quentin I. Wilcox, West Bend, and Allen E. Cooper, Hartford, Wis., assignors to Chrysler Corporation, Highland Park, Mich., a corporation of Delaware

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Int. Cl. B63h 21/26

ABSTRACT OF THE DISCLOSURE

An inboard-outboard drive assembly for a boat wherein the gear means interconnecting the horizontal drive shaft from the inboard power unit and the vertical drive shaft of the outboard propulsion unit is centered on the pivotal axis of the propulsion unit so that the pivotal movement of the propulsion unit is accompanied by readjustment of the relative angular positions of the various gears of the interconnecting gear means. Also, an inboard-outboard drive unit which includes a damping assembly comprising a shaft, an elastomer sleeve member bonded to the shaft, and a socket member receiving the sleeve member with a frictional sliding fit. The shaft is rotated in response to pivotal movement of the propulsion unit so that the initial upward pivotal movement of the propulsion unit is absorbed by yielding of the elastomer member, whereafter the elastomer member breaks loose within the socket to provide a frictional sliding resistance to further pivotal movement of the propulsion member.

Background of the invention

This invention relates to an inboard-outboard drive for a water craft. More particularly, it relates to the manner in which the horizontal drive shaft of the inboard power unit is drivingly interconnected to the vertical drive shaft of the outboard propulsion unit as well as the manner in which the upward pivotal movement of the propulsion unit is damped.

Summary of the invention

It is a general object of the present invention to provide an improved inboard-outboard drive assembly for a water craft.

A more specific object of the present invention is to provide an improved arrangement for interconnecting the drive shafts of the inboard power unit and the outboard propulsion unit.

Another object is to provide an improved arrangement for damping the upward pivotal movement of the propulsion unit.

Another object is to provide an improved damping system which also functions as a tilting system to voluntarily raise the propulsion unit partially or completely out of the water.

The inboard-outboard drive assembly of the invention is of the type including a drive shaft extending horizontally from the inboard power unit rearwardly through the transom of the craft and a propulsion unit disposed outboard of the craft and comprising a drive leg normally depending downwardly to position a propeller carried on the lower end of the drive leg in the water. One aspect of the invention concerns the manner in which the pivotal movement of the propulsion unit is damped. The damping assembly of the invention includes a shaft having an elastomer sleeve member bonded to one end thereof with the elastomer member in turn received with a frictionally sliding fit in a normally fixed socket member. Means are provided to rotate the shaft in response

to pivotal movement of the propulsion unit so that the elastic material of the elastomer member yields during the initial upward pivotal movement of the propulsion unit, whereby to provide relatively little resistance to such initial movement, whereafter the elastomer member and socket undergo relative rotation at their frictional interface to provide frictional sliding resistance to further pivotal movement of the propulsion member.

According to another feature of the invention, the means which operate to rotate the damping shaft in response to upward pivotal movement of the propulsion unit also operate in reverse; that is, to pivot the propulsion unit upwardly in response to rotation of the damping shaft. Accordingly, by suitably rotating the socket member, the propulsion unit may be voluntarily raised out of the water for purposes of launching, shallow water operation, etc.

According to another feature of the invention, the gear means drivingly interconnecting the horizontal drive shaft from the inboard power unit and the vertical drive shaft of the propulsion unit includes a gear member which is mounted for rotation on the pivotal axis of the propulsion unit so that the pivotal movement of the propulsion unit is accompanied by a readjustment of the relative angular positions of the various gears of the interconnecting gear means without disturbing the meshing engagement of the various gears.

Brief description of the drawings

A preferred embodiment of the invention is shown in the accompanying drawings. In the drawings:

FIG. 1 is a cross-sectional view of an inboard-outboard drive assembly embodying features of the present invention; and

FIG. 2 is a fragmentary cross-sectional view taken on line 2—2 of FIG. 1.

Detailed description of a preferred embodiment

The inboard-outboard drive assembly of the present invention includes an internal combustion engine seen fragmentarily at **10** and adapted to be disposed in the rear portion of a water craft immediately forwardly of the transom **12**, a housing member **14** secured as by bolts **16** to engine **10** and extending through an opening **17** in transom **12** to a location outboard of the craft, and a propulsion unit comprising a drive leg **18** suspended from housing **14** in a position outboard of transom **12**.

Housing **14** is of cored construction and includes a socket portion **14***a* receiving a bearing sleeve member **20**. Sleeve member **20** accommodates tapered roller bearings **22** and **24** journaling the output shaft **26** of engine **10** within housing **14**. Housing **14** further includes a partition **14***b* mounting a seal **28** sealingly engaging output shaft **26**. A bevel gear **30** is carried on the distal end of drive shaft **26**, and a bellows seal **32** is disposed generally within transom opening **17** and extends between transom **12** and housing **14** to provide a water seal therebetween. Seal **32** is fastened to the outer face of transom **12** by a clamping ring **34** and to housing **14** by a clamping ring **36**. Housing **14** is bifurcated beyond socket portion **14***a* to provide a left support arm **14***c* and a right support arm **14***d*, as viewed in FIG. 2. Arms **14***c* and **14***d* journal a generally horizontal pivot shaft **38**.

Drive leg **18** includes an upper housing **40**, an intermediate housing **42** and a lower housing **43**. Housing **40** defines at its upper end a pair of laterally spaced ears or arms **40***a* and **40***b* keyed to horizontal pivot shaft **38**. Housing **40** further includes a vertically elongated central hub portion **40***c* and an outer flange portion **40***d*. The upper end of central hub portion **40***c* defines a socket portion **40***e* receiving a tapered roller bearing **44**. Roller bearing **44** journals the upper end of a vertically oriented

drive shaft **46** extending downwardly within center hub portion **40***c*. A bevel gear **48** is provided at the upper end of vertical drive shaft **46**. Bevel gear **48** is interconnected with bevel gear **30** on horizontal drive shaft **26** by a bevel gear **50** journaled on horizontal pivot shaft **38**.

Intermediate housing **42** includes an upper hub portion **42***a* housing a bearing **52** journaling intermediate housing **42** on the central hub portion **40***c* of upper housing **40**. A ring member **54** received in a groove **42***d* defined by intermediate housing **42** provides a rotary seal between housing **42** and flange portion **40***d* of housing **40**. Housing **42** further includes a lower central hub portion **42***c* connected to the main body of the housing by a vertical rib **42***d* and defining at its upper end a socket **42***e* receiving a bearing **56** journaled on the lower end of hub portion **40***c* of upper housing **40**.

Lower housing **43** defines a central cavity **43***a* receiving a transmission seen generally at **58**. Transmission **58** includes a propeller shaft **60** journaled in a tapered roller bearing **62** received in a socket **64***a* defined by a bearing block **64** mounted by bolts **66** in a position plugging the rear end of cavity **43***a*. The forward end of shaft **60** is journaled in a tapered roller bearing **69** carried by a partition portion **43***b* of lower housing **43**. Housing **43** also defines a socket **43***c* for receipt of a tapered roller bearing **68** journaling a bevel gear **70** splined to the lower end of vertical drive shaft **46**. Bevel gear **70** engages a forward bevel gear **72** and a rearward bevel gear **74**. A clutching collar **76** carried on a shift rod **78** coaxial with propeller shaft **60** operates in known manner to transmit drive to propeller shaft **60** either through forward bevel **72** or rearward bevel **74**. Shift rod **78** is selectively slidable pivotal movement of a bellcrank lever **80** operated by a control rod **82**. A propeller **84** is keyed to the distal end of propeller shaft **60**.

The operation of the inboard-outboard drive of the invention as thus far described is thought to be readily apparent. Rotation of inboard engine output shaft **26** rotates bevel gear **30** and thereby bevel gears **50** and **48**. Gear **48** drives vertical drive shaft **46** and thereby bevel gear **70**. Bevel gear **70** drives bevel gears **72** and **74** to transmit either a forward or reverse drive to propeller shaft **60** depending on the position of clutching collar **76**. Shifting of transmission **58** between forward and reverse drives is accomplished by reciprocal movement of control rod **82**, which movement maybe accomplished either manually or with power assist.

When lower fin portion **43***d* of lower housing **43** strikes an obstacle, drive leg **18** is kicked upwardly, pivoting about the axis of pivot shaft **38**. During this upward pivotal movement, bevel gear **48** simply rides up on bevel gear **50** so that, although the relative angular positions of the bevel gears are thereby readjusted, the meshing engagement of the bevel gears is not disturbed.

A bevel gear segment **86** is keyed to horizontal pivot shaft **38**. Gear **86** engages a bevel gear **88** splined to the rearward end of a horizontal damping shaft **90**. Shaft **90** is rotatably received within a cavity **14***e* in housing **14** and extends horizontally forwardly from bevel gear **88**. Shaft **90** is splined intermediate its ends at **90***a* for splined engagement with a sleeve member **92**. A pair of elastomer rings **94** are bonded at their inner periphery to the outer periphery of sleeve member **92**. The outer peripheries of elastomer members **94** are received with a frictional sliding fit in a sleeve or socket member **96** journaled in a further cavity **14***f* of housing **14**. Sleeve **96** may be formed of asbestos or other hard, smooth-surfaced material capable of maintaining a fairly constant coefficient of friction over periods of extended usage. The forward end of sleeve **96** is rigidly secured to a worm pinion **98** engaging a worm gear **100** received within a vertical cavity **14***g* defined by housing **14**. The portion of shaft **90** forward of splined portion **90***a* passes through the interior of sleeve **92** and through worm gear **98** for engagement with an elastic stop nut **102**; nut **102** precludes axial movement of worm gear **98** off of shaft **90**.

Bevel segment gear **86**, bevel gear **88**, shaft **90**, elastomer members **94** and socket **96** will be seen to provide a mechanism for damping the upward pivotal movement of drive leg **18**. Specifically, as drive leg **18** is kicked upwardly upon hitting an obstacle, pivot shaft **38** rotates gear segment **86** which in turn rotates bevel gear **88** and shaft **90**. The initial rotary movement of shaft **90** is absorbed by yielding of the elastic material of the elastomer members **94** so that relatively little resistance is offered to such initial movement. Further rotary movement of shaft **90** occurring in response to further upward pivotal movement of the drive leg, exhausts the ability of the elastomer members to yield and causes the elastomer members to break loose at their interface with socket **96** so that such further movement is resisted by the rotary sliding friction between elastomer members **94** and socket **96**.

The geared interconnection between horizontal drive shaft **26** and vertical drive shaft **46** is sealed from the water by a flexible bellows-type seal **104** of elastomer material. Seal **104** is clamped to upper drive leg housing **40** by clamping ring **106** and to housing **14** by clamping member **108**. Further water sealing protection is afforded to the internal gear mechanisms by an auxiliary housing member **110** suitably secured to housing **14** and extending in an arc centered on the axis of pivot shaft **38** to a location below that shaft. An arcuate slot **112** in auxiliary housing **110** accommodates upward pivotal movement of propulsion unit **18**. A plurality of telescopically arranged arcuate vanes **112** pivoted on pins **114** normally close slot **112** but telescope upon themselves to allow drive leg **18** to pivot upwardly into the slot. A tilt adjustment pin **116** received in one of a plurality of holes **118** provided in a flange portion **40***f* of upper drive leg housing **40** coacts with a snubber-face **14***h* to selectively adjust the tilt angle or "trim" of the drive leg.

We claim:

1. In an inboard-outboard drive assembly for a watercraft including an inboard power unit, a drive shaft extending generally horizonally from said power unit rearwardly through the transom of the craft, a propulsion unit disposed outboard of said craft and comprising a drive leg normally depending downwardly to position a propeller carried on the lower end thereof in the water, and means mounting said drive leg for pivotal movement relative to said drive shaft and said craft about a generally horizontal axis to allow said drive leg to pivot upwardly upon striking an underwater object to prevent damage to said assembly; the improvement wherein said mounting means includes

(A) a damping shaft;

(B) means operative in response to the aforesaid upward pivotal movement of said drive leg to rotate said damping shaft about its lengthwise axis;

(C) an elastomer member secured to said damping shaft and presenting a cylindrical surface concentric with said lengthwise shaft axis; and

(D) a normally fixed member presenting a cylindrical surface concentric with said lengthwise shaft axis and telescopically arranged relative to said elastomer member cylindrical surface, said members having a frictional sliding fit at the interface of said surfaces to allow frictionally resisted relative rotation of said members so that the elastic material of said elastomer member yields during the initial upward pivotal movement of said drive leg about said horizontal axis, whereafter said members undergo relative rotation at their frictional interface to provide frictional sliding resistance to further upward pivotal movement of said leg.

2. An inboard-outboard drive assembly according to claim **1** wherein

(E) said elastomer member comprises a cylindrical

sleeve concentrically surrounding, and bonded to, a portion of said damping shaft; and

(F) said normally fixed members comprises a cylindrical socket receiving said elastomer sleeve with a fit allowing, but frictionally resisting, rotation of said sleeve within said socket.

3. An asembly according to claim 1 wherein:

(E) said operative means are also operative to pivot said drive leg upwardly about said horizontal axis in response to rotation of said damping shaft about said lengthwise axis; and

(F) said assembly further includes means for rotating said normally fixed member about said lengthwise axis, whereby said drive leg may be pivoted upwardly by selective actuation of said rotating means.

4. An assembly according to claim 1 wherein

(E) said damping shaft is disposed generally parallel to said drive shaft; and

(F) said operative means includes a right angle gear connection between said drive leg and said damping shaft.

5. An assembly according to claim 4 wherein

(G) said damping shaft extends forwardly through said transom to dispose its forward end within said water craft;

(H) said elastomer member comprises a cylindrical sleeve secured to said forward end of said damping shaft;

(I) said normally fixed member comprises a cylindrical socket disposed within said water craft and receiving said elastomer sleeve with a frictional sliding fit; and

(J) said assembly further includes means within said water craft engaging said socket and operative to selectively rotate it about said damping shaft axis to selectively pivot said drive leg upwardly.

6. An assembly according to claim 5 wherein

(K) said assembly further includes a housing secured to the rearward end of said inboard power unit and extending rearwardly therefrom through an opening in said transom, said housing journaling said drive shaft and damping shaft therewithin in side by side relation and adjacent its rearward end journaling said drive leg for its aforesaid pivotal movement about said horizontal axis.

7. An inboard-outboard drive assembly for a water craft comprising

(A) an inboard power unit;

(B) a drive shaft extending generally horizontally from said power unit for passage through the transom of said craft;

(C) a propulsion unit disposed outboard of said craft and including a drive leg carrying a propeller on the distal end thereof;

(D) means adapted to be secured to said transom mounting said drive leg for pivotal movement about a generally horizontal axis between a working position in which said leg depends downwardly to dispose said propeller in the water and a raised position in which said leg is pivoted upwardly from its working position;

(E) a drive shaft lying in the plane of said horizontal drive shaft and extending longitudinally of said drive leg for driving connection with said propeller;

(F) gear means drivingly interconnecting said horizontal drive shaft and said drive leg drive shaft and a first bevel gear mounted for rotation on said drive leg pivotal axis, a second bevel gear on the rearward end of said horizontal drive shaft meshingly engaging said first bevel gear, and a third bevel gear on the upper end of said drive leg drive shaft meshingly engaging said first bevel gear;

(G) a fourth bevel gear on said drive leg pivotal axis arranged to be rotated about that axis in response to pivotal movement of said drive leg about that axis;

(H) a damping shaft extending generally parallel to said horizontal drive shaft;

(I) a fifth bevel gear on the rearward end of said damping shaft meshingly engaging said fourth bevel gear so that said damping shaft is rotated in response to pivotal movement of said drive leg;

(J) an elastomer member secured to said damping shaft and presenting a cylindrical surface concentric with the lengthwise axis of said damping shaft; and

(K) a normally fixed member presenting a cylindrical surface concentric with said lengthwise shaft axis and telescopically arranged relative to said elastomer member cylindrical surface, said members having a frictional sliding fit at the interface of said surfaces to allow frictionally resisted relative rotation of said members so that the elastic material of said elastomer member yields during the initial upward pivotal movement of said drive leg about said horizontal axis, whereafter said members undergo relative rotation at their frictional interface to provide frictional sliding resistance to further upward pivotal movement of said leg.

8. An assembly according to claim 7 wherein said assembly further includes

(L) means engaging said normally fixed member and operative to selectively rotate it about said damping shaft axis to selectively pivot said drive leg upwardly.

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TRYGVE M. BLIX, *Primary Examiner.*