March 17, 1970 J. BECKER 3,500,787

ARRANGEMENT OF TILTABLE STEERABLE PROPELLER

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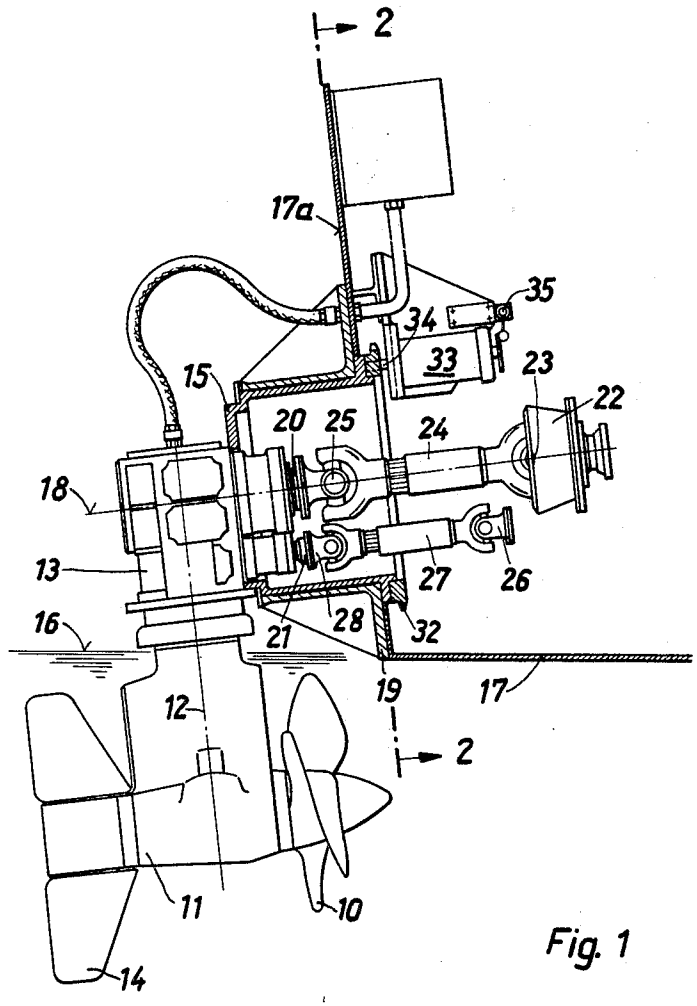


Fig. 1

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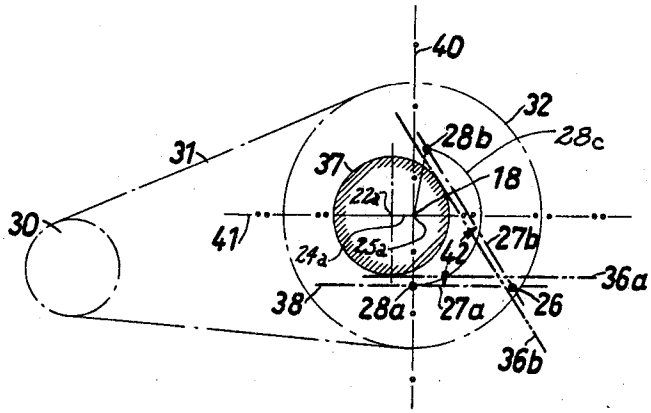


Fig. 2

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ARRANGEMENT OF TILTABLE STEERABLE PROPELLER

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U.S. Cl. 115—41 4 Claims

ABSTRACT OF THE DISCLOSURE

A steerable propeller for driving watercraft, said steerable propeller being pivotable about a vertical axis for the purpose of controlling the watercraft and being arranged for pivoting about a horizontal axis on a drum-shaped neck with sleeve bearings for being lifted out of the water. The drum-shaped neck at least partly surrounds a cardan shaft for the propeller drive and a cardan shaft for the control drive and one of the cardan shafts, preferably the one for the propeller drive, is arranged approximately in the pivot axis.

This invention relates to an arrangement of a steerable propeller for inboard-outboard motor watercraft in which the propeller is arranged on a housing containing the gear unit, which housing is located below the surface of the water during normal operation, which is pivotable through 180 degrees, more or less, about an axis substantially inclined to the water level, for example at an angle of 90 degrees, for the purpose of guiding the craft, in which the propeller can be lifted out of the water about another axis which for example is parallel to the surface of the water, and in which the drive for the thrust rotation (torque) of the propeller and the drive for the steering movement of the propeller are driven each through a shaft connection which permits a change in the angle of the unit or which permits an axial misalignment. At least one of said connections allows an elongation thereof, for example through a cardan shaft.

The purpose of such steering propellers pivotable at 180 degrees about a vertical axis is to control and to drive the watercraft in reverse with a very small turning circle without changing the direction of rotation of the driving system. If the propeller, as above-described, can be lifted out of the water, the draft of the craft can by this be reduced on one hand, as to facilitate loading and unloading of the craft, and on the other hand, when the craft is floating, the propeller and the gear unit which are otherwise under water are accessible for repairs.

It is known to lift the housing carrying the propeller out of the water about an axis which is approximately parallel to the side of the craft on or adjacent which the propeller is located, which thus is for example parallel to the stern. If such an arrangement uses non-releasable couplings for the gear unit connections for torque and control drive, then the lift angle is limited, namely to such a value that the steering propeller projects substantially to the rear when same is lifted out of the water. If it is desired to lift same still further, then releasable couplings are absolutely necessary. Said couplings increase the manufacturing expense, make handling more difficult and are undesirable at least for the steering drive because a predetermined relation must be maintained between the steering wheel or the steering indicator and the pivotal housing (German Patent No. 948,854).

A drive for watercraft, preferably amphibian boats, having a steering propeller is already known in which the plane in which the housing carrying the propeller moves

as it is lifted out of the water is approximately parallel to the surface on or adjacent which the propeller is mounted and is approximately perpendicular to the shafts transmitting the torque and/or the steering drive. In this arrangement, there is less room required for the lifting of same out of the water and no couplings must be released for the lifting operation; however, such arrangement is, with respect to its position in the lifting plane, much too weak and unstable. The latter is particularly important for the reason that this arrangement requires so-called cardan joints which do not transmit a constant torque. Instead, pulsation of the torque is increased as the cardan shafts are increasingly bent. Some movable joints are already known which not not give out a pulsating torque, however, same do not operate as free from maintenance requirements as the successful cardan joints and are not as strong (German Patent No. 1, 141,557).

It is the purpose of this invention to provide an arrangement of a steering propeller which requires only a little room when being lifted out of the water and in which the gear unit connections between the torque and steering drive and the steerable propeller do not have to be released during lifting. Thus, adjustments, pin, safety devices and the like may be avoided. Moreover, it is assured that the propeller can also effect a pivoting as for steering purposes when in lifted condition without changing the relative lifted position of the propeller (resulting from such pivoting) and the steering indicator. Further, the steering propeller should be positioned as rigidly as possible in order that it can absorb torque variations or other forces without displacement. Still further, such variations are substantially suppressed.

To attain said purpose the invention provides a housing for carrying the propelled which is radially supported for the purpose of lifting same out of the water by means of a cylindrical sleeve bearing which partially encloses the two shaft connections or their connections to the steerable propeller by which a particularly strong and oscillation damping arrangement is obtained.

The oscillation damping effect is according to the invention still further improved by providing the axial bearing also as a sleeve bearing. The lifting out of the water is made easier and at the same time oscillations originating with the cardan shaft are avoided or at least lessened because the shaft connection transmitting the torque for the propeller, for example the torque cardan shaft, is arranged at least approximately in the lifting axis.

The invention further with respect to the afore-discussed purpose provides that both shaft connections are connected on the driving side and also on the driven side by means of couplings which are not released during the lifting movement to thus maintain unchanged the relative position of the steering drive to the driven means in all operating positions or lifting positions. These types of shaft connections are already known in steerable propellers (German Patent No. 1,141,557), however, they are especially advantageous in combination with the afore-described invention.

For the arrangement as above-described, such a structure is advantageous for effecting ease of handling, safety in operation and freedom of pivoting in that the connection between the driving coupling and the driven coupling of one shaft connection, for example the steering cardan shaft or its extension, lies in its operating position, and/or in the extreme outwardly lifted position of the propeller, outside the tangential lines (which are parallel to both connections) on the working zone of the other shaft connection, for example the torque cardan shaft. By this the steering cardan shaft during lifting of the propeller out of the water can, so to speak, wind around the torque cardan shaft. It can also be advantageous in some cases if the

torque cardan shaft winds, so to speak, around the control cardan shaft. The "working zone" is the space which a shaft occupies or needs when the steerable propeller is lifted.

With respect to the operating aspects of the apparatus, one advantageous construction comprising the invention is that the working zone of the one shaft connection, for example of the torque cardan shaft, is between the sides of the angle which is formed by the driving coupling and the two extreme positions of the driven coupling of the other gear unit connection, for example of the steering cardan shaft. A further characteristic of the invention is a structure in which the driving coupling of the one shaft connection, for example of the steering cardan shaft, is arranged laterally in relation to a plane going through the center of the driving coupling of the other shaft connection, for example torque cardan shaft, and positioned perpendicular to the surface of the water. It is thereby less important whether or not the driving coupling is positioned, for example, above the horizontal plane going through the axis of the torque cardan shaft, or is positioned, as later described by means of the illustrated embodiment, below said plane.

With respect to the arrangement of the driven coupling, this is advantageously handled so that the extreme positions of the driven couplings of the one shaft connection, for example of the steering cardan shaft, are positioned above or below a plane which is positioned through the center of the driven coupling of the other shaft connection, for example the torque cardan shaft, parallel to the surface of the water.

The invention is further illustrated by one embodiment in the drawings in which

FIGURE 1 is a longitudinal cross-sectional view of one embodiment of the invention,

FIGURE 2 is a schematic cross-sectional view of the couplings of the shaft connections arranged according to the invention and taken on the line **2**—**2** of FIGURE 1.

FIGURES 1 and 2 illustrate one embodiment of the invention. The propeller **10** is provided in a known manner in an underwater housing **11** having the underwater portion of its gear unit arranged therein. Said underwater housing is supported pivotably about a pivot axis **12** which is vertical when in operation. Said underwater housing is operated by the above-water housing **13** which has the above-water part of the propeller gearing arranged therein. The underwater housing which is pivotable in the manner described is provided with a fin **14** used as a torque support. Said above-water unit is fixedly mounted to a cylindrical neck **15** which is rotatably supported about a lift axis **18** which is in turn parallel to the water level **16** and positioned in the driving direction of the watercraft **17** in a neck journal **19** mounted to a suitable part of the craft. The above-water housing being pivotable (liftable) in this manner can be secured in desired positions, for example in the illustrated operating position, in the manner as later described. The neck is sealed and secured in the neck journal against longitudinal movement.

By pivoting the underwater housing about the axis **12**, the direction of thrust of the propeller is changed and the craft is steered in this manner. If the propeller is swung beyond 90 degrees, for example 180 degrees, as compared to the position of FIGURE 1, the craft can change from forward driving to driving in reverse without reversing the driving engine. By rotating the above-water housing **13** about the lift axis **18**, the propeller can be lifted upwardly out of the water, for example at 180 degrees from the position of FIGURE 1. The propeller can also be secured in said upwardly lifted position, as will be described later.

The positions of the described axes **12** and **18** do not necessarily have to be as above described. It is only of importance that pivot axis **12** can be used to change the driving direction and that lift axis **18** can be used to lift

the propeller upwardly out of the water. However, it is important for the invention that the lift axis is at least approximately parallel to the axis of the driving shaft **20** and to the axis of the driving shaft **21** in the above-water gear unit. A slight inclination of the drive shaft **24** with respect to the axis **18** is advantageous for improving the lubrication of the cardan joints. If, for example the propeller would not, as illustrated, be arranged at the stern of the craft but at the side of the craft, the lift axis would not be positioned in driving direction but perpendicular thereto.

The drive for the torque or thrust of the propeller is performed by a driving engine (not illustrated) and acts through a suitable gear unit (not illustrated) onto a resilient coupling **22**. From there, the torque is transmitted through a driving coupling **23** (relative to the cardan shaft following thereafter), a torque cardan shaft **24** and a driven coupling **25** (relative to the cardan shaft in front of same) to the torque driving shaft **20**.

The drive for the steering movement of the underwater housing **11** or the propeller **10** is transmitted from a steering wheel or the like, not illustrated, which advantageously is connected to a not illustrated steering indicator through a driving coupling **26** (also schematically indicated in FIGURE 2), a steering cardan shaft **27** and a steering driven coupling **28** to the control driving shaft **21**.

The drive for the neck supporting the above-water housing, namely the drive for the lifting movement of the propeller, is provided by any suitable crank or motor (neither illustrated) through a driving sprocket **30** and a chain or the like onto a sprocket **32** which is secured at the neck. The aforementioned locking mechanism cooperates with said sprocket. Said locking mechanism can, for example, be a plunger **34** which is operated by a locking piston arranged within a hydraulic cylinder **33**, said plunger for example being able to engage the tooth spaces of the sprocket. A conventional switching arrangement **35** de-energizes the hydraulic unit in either or both final positions of said locking piston. By means of said locking mechanism it is made possible for the propeller, apart from the sprocket pitch, to be locked in any desired lifted positions.

The invention is such a shaft arrangement in the torque and steering drive means that no coupling needs to be released in order to lift the propeller. Coupling **22** is centered at one side of the vertical plane **40** through the pivot axis **18** and coupling **25** is centered on axis **18**. When the centers of these parts are projected onto a plane perpendicular to the axis **18**, they appear (FIGURE 2) as points **22***a* and **25***a* with the axis of shaft **24** appearing as **24***a*. Circle **37** indicates on the same plane the working circle of the drive shaft **24**. Correspondingly, the driving coupling **26** and the driven coupling **28** of cardan shaft **27** are so arranged that the axis **27***a* (FIGURE 2) of the cardan shaft **27** when in its operating position is below the parallel line **36***a*, said parallel line being a line tangent to the working zone (working circle **37**) of the driving shaft **24**. A corresponding arrangement is used for the upwardly lifted position of the propeller. FIGURE 2 illustrates in this position the axis **27***b* of the cardan shaft **27** when in raised position and further illustrates at **36***b* the line which is parallel to line **27***b* and tangent to said working zone. This movement of the shaft **27** defines a surface of a cone, the apex of which being located at **26** as shown in FIGURE 2. The described arrangement refers, according to the invention, not only to the steering shaft **27** but can also be used for its extensions, for example as indicated at **38** in FIGURE 2. The relative relationships of the steering cardan shaft and driving cardan shaft can also be reversed.

In further detail, the driving coupling **26** is arranged at the other side of said vertical plane **40**. When the propeller is in its downward, or operating position the driven coupling **28** is positioned at point **28***a* below the horizontal plane **41** extending through the axis **18** of

the torque cardan shaft. When the propeller is in its upward, lifted, position, the coupling **28** travels on path **28***c* from point **28***a* around the axis **18** to the upper point **28***b*, the shaft **27** extending sufficiently in length to make this movement possible. In such position, as above mentioned, the axis of said shaft **27** when viewed from the leftward end of FIGURE 1, will coincide with the line **27***b* (FIGURE 2), and will be above the plane **41**.

This invention creates an easily transportable motor-driven watercraft, the propeller of which with the drive can also be serviced and repaired when the craft is floating without the danger that the position of the propeller with respect to the steering indicator is being disturbed.

Patents which were taken in consideration: German Patent No. 948,854; German Patent No. 1,141,557.

Although particular preferred embodiments of the invention have been disclosed for illustrative purposes, it will be recognized that variations of modifications of such disclosure are fully contemplated.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A rotatably supported propeller drive system for watercraft, comprising:

an upper housing rotatably mounted to said watercraft above the waterline for movement between first and second positions;

a lower housing pivotable about a substantially vertical axis secured to said upper housing and extending below the waterline when said upper housing is in said first position;

a propeller rotatably mounted on said lower housing;

a rotatable first input shaft and a rotatable second input shaft to said upper housing, said input shafts extending from said upper housing toward the interior of said watercraft, said first input shaft providing power to said propeller, said second input shaft providing power for steering said watercraft, said first input shaft being coincident with said axis of rotation of said upper housing, said second input shaft being radially offset therefrom;

first and second drive shaft means connected, respectively, at one end to the free ends of said first and second input shaft, the other end of said first drive shaft means being supported for rotation by means located at a first fixed point approximately coincident with axis of rotation of said upper housing to position said first drive shaft means approximately coincident with the axis of rotation of said upper housing, said second drive shaft means being longitudinally extendable with the other end thereof being supported for rotation by means located at a second fixed point;

said second fixed point being spaced from said first fixed point a distance greater than the spacing between said first and second input shafts;

means on said watercraft for rotating said upper housing between said first and second positions to thereby move said second input shaft in an arcuate path about said first input shaft and said axis of rotation, said longitudinally extendable drive shaft means accommodating a change in the space between said free end of said second input shaft and the second fixed point, said first drive shaft means and said longitudinally extendable drive shaft means diverging away from said upper housing, said means for rotating said upper housing moving the end of said longitudinally extendable drive shaft means connected to said second input shaft around said axis of rotation and said first input shaft, the end of said longitudinally extendable drive shaft means secured to said means located at said fixed point remaining fixed whereby the movement of said longitudinally extendable drive shaft defines a partial surface of an oblique cone having a partially circular-shaped base, the center point of the partical circular-shaped base being located at the position of said first input shaft, the apex of said cone being located at said second fixed point, said divering positioning of said first drive shaft means and said longitudinally extendable drive shaft means and the spacing between said first and second fixed points preventing a touching therebetween during the movement of said upper housing from said first position to said second position, whereby said lower housing may be moved to said second position wherein said lower housing is positioned above said waterline without necessitating a disconnection of said drive shaft means from the respective ones of said first and second input shafts and said first and second fixed points.

2. A rotatably supported propeller drive system for watercraft, comprising:

an upper housing rotatably mounted to said watercraft above the waterline for movement between first and second positions;

a lower housing pivotable about a substantially vertical axis secured to said upper housing and extending below the waterline when said upper housing is in said first position;

a propeller rotatably mounted on said lower housing;

a rotatable first input shaft and a rotatable second input shaft to said upper housing, said input shaft extending from said upper housing toward the interior of said watercraft, one of said input shafts providing power to said propeller, the other of said input shafts providing power for steering said watercraft, one of said input shafts being radially offset from the axis of rotation of said upper housing, the other of said input shafts being coincident with said axis of rotation of said upper housing;

first and second drive shaft means connected at one end to the free ends of said first and second input shafts, respectively, the other end of said first drive shaft means being supported for rotation about a first fixed point, the other end of said second drive shaft means being supported for rotation about a second fixed point, said first and second fixed points being spaced a distance greater than the spacing between said first and second input shafts;

means on said watercraft for rotating said upper housing between said first and second positions to thereby move said offset one of said first and second input shafts in an arcuate path about said other of said input shafts and said axis of rotation, the one of said drive shaft means connected to the offset one of said input shaft moving about said axis of rotation to define the surface of half of an oblique cone having a semi-circular-shaped base, the center point of the semi-circular-shaped base being located at the position of said one of said input shafts, the apex of said cone being located at the fixed point associated with the offset one of said drive shaft means whereby said lower housing may be moved to said second position wherein said lower housing is positioned above said waterline without necessitating a disconnection of said drive shaft means from the respective ones of said first and second input shafts and said first and second fixed points.

3. The drive system defined in claim **2**, wherein said first fixed point is axially spaced from the free end of said first input shaft and is radially offset from the axis thereof; and

wherein said axis of said first input shaft is coaxial with said axis of rotation of said upper housing; and

wherein said first drive shaft means includes universal joints at both ends of a first drive shaft to interconnect said first drive shaft to said first input shaft and to other means located at said first fixed point.

4. The drive system defined in claim **3**, wherein said second input shaft is radially offset from said axis of

rotation and said second fixed point is axially spaced from said free end of said second input shaft and is radially offset from the axis thereof; and

wherein said second drive shaft means includes universal joints at both ends of a longitudinally extendable drive shaft to interconnect said longitudinally extendable drive shaft to said second input shaft and to other means located at said second fixed point.

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TRYGVE M. BLIX, Primary Examiner

U.S. Cl. X.R.

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