Dec. 27, 1966 T. O. JONES 3,294,052

STEERING MECHANISM FOR HYDROFOIL BOATS

Filed May 13, 1965 3 Sheets-Sheet 1

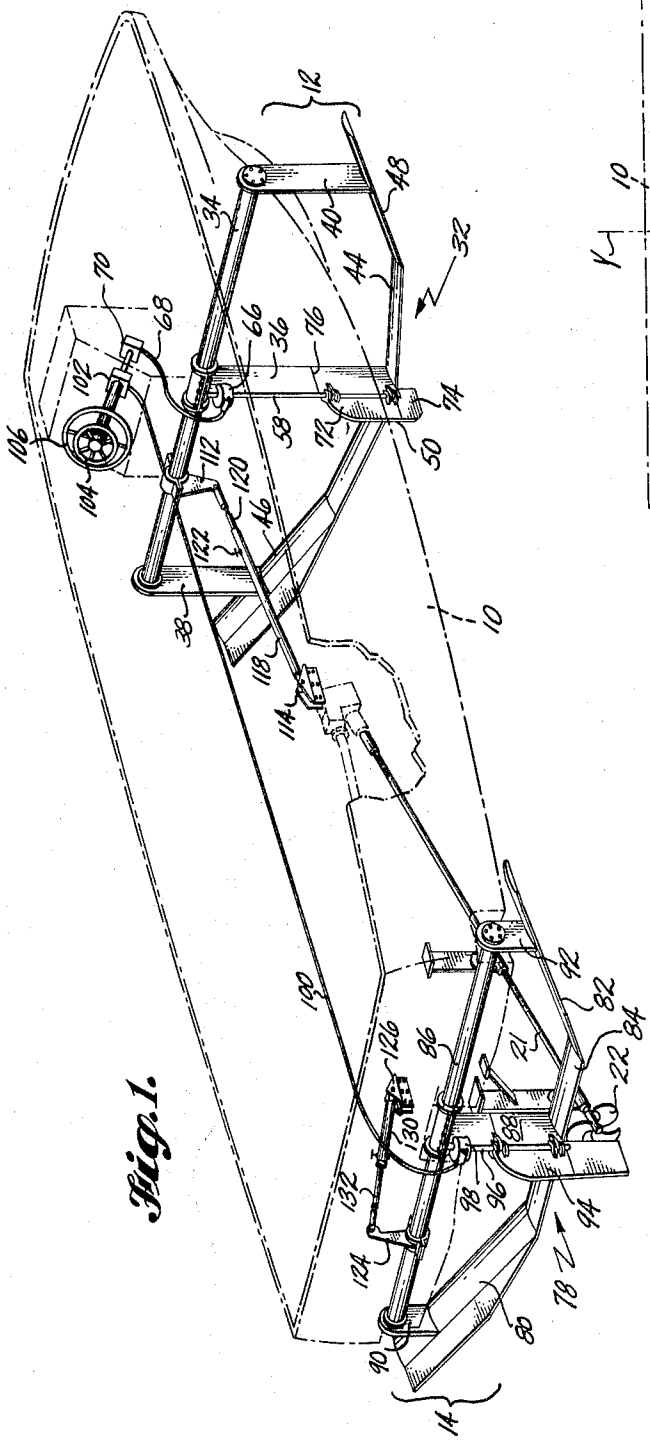

Fig. 1.

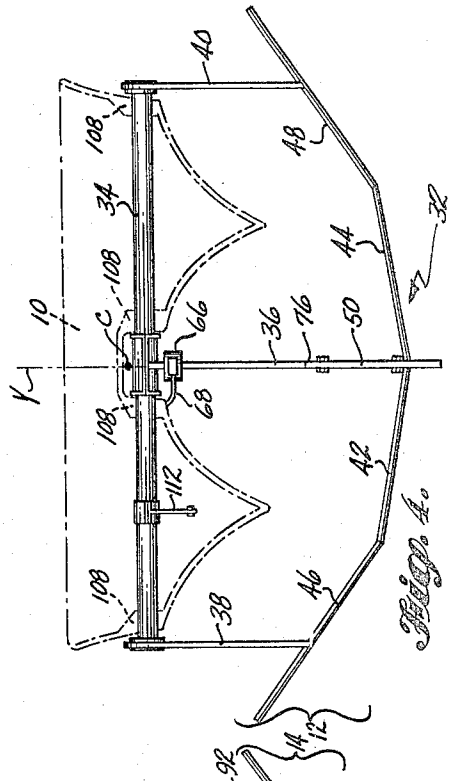

Fig. 4.

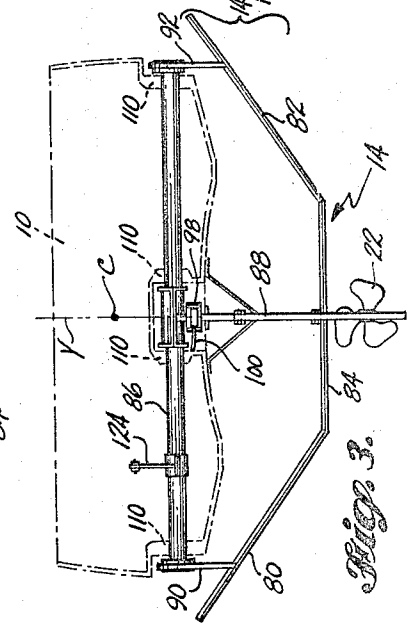

Fig. 3.

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STEERING MECHANISM FOR HYDROFOIL BOATS

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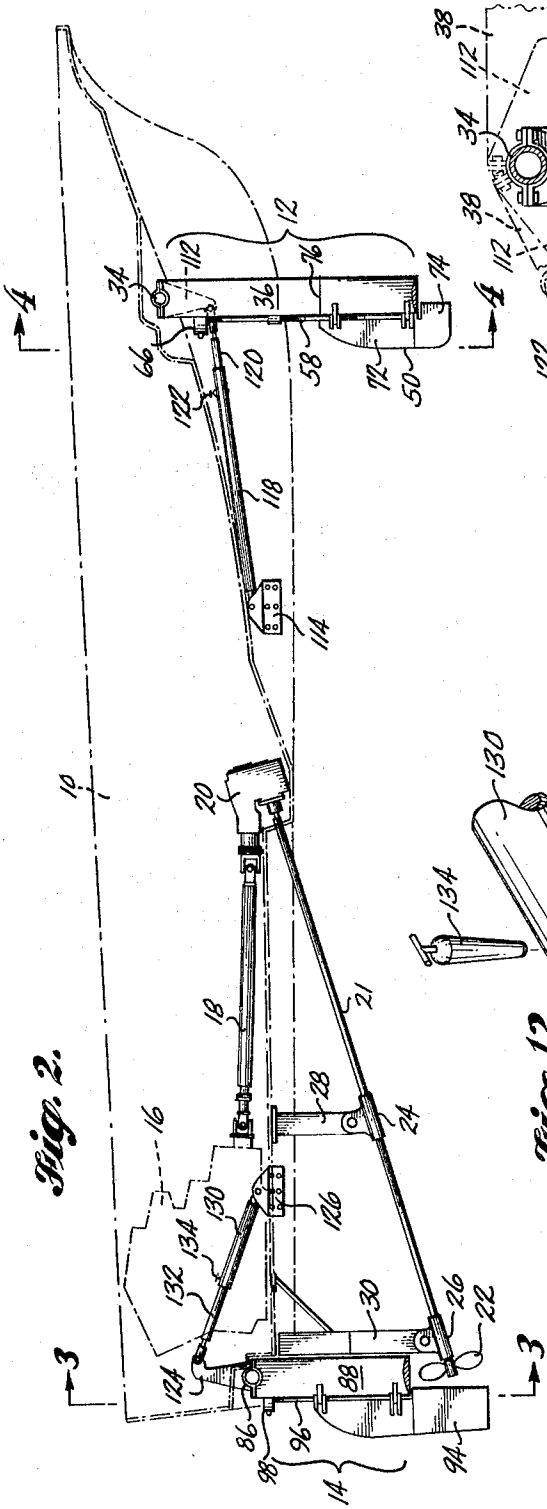

Fig. 2.

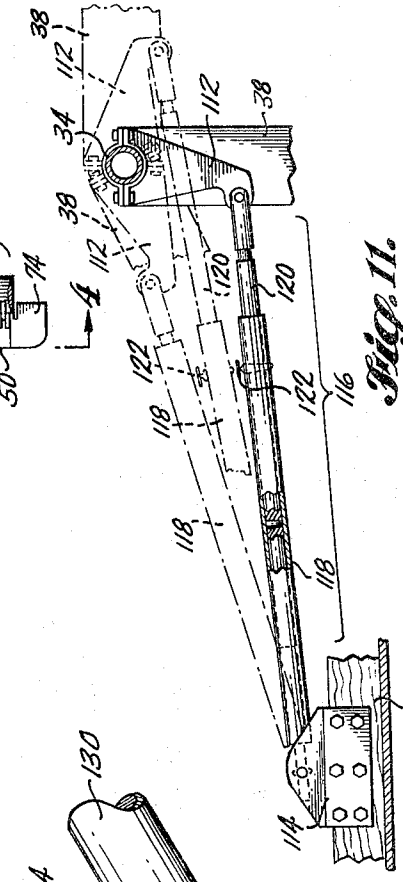

Fig. 11.

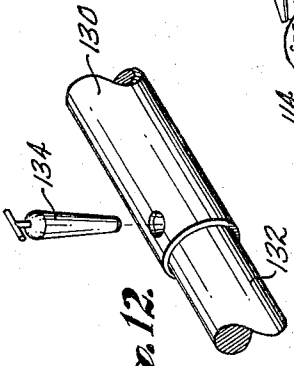

Fig. 12.

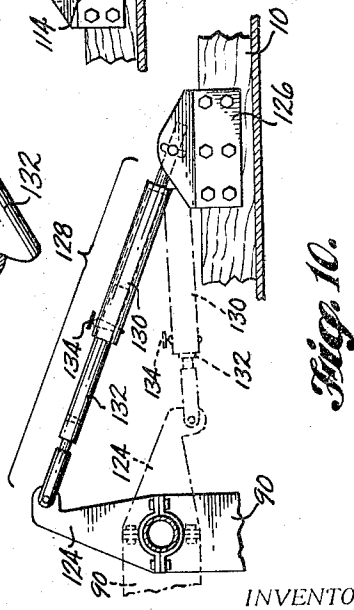

Fig. 10.

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STEERING MECHANISM FOR HYDROFOIL BOATS

Filed May 13, 1965 3 Sheets-Sheet 3

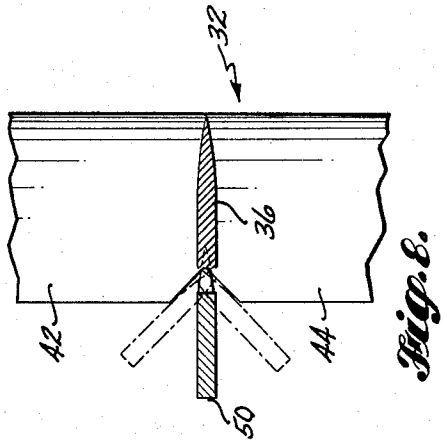

Fig. 8.

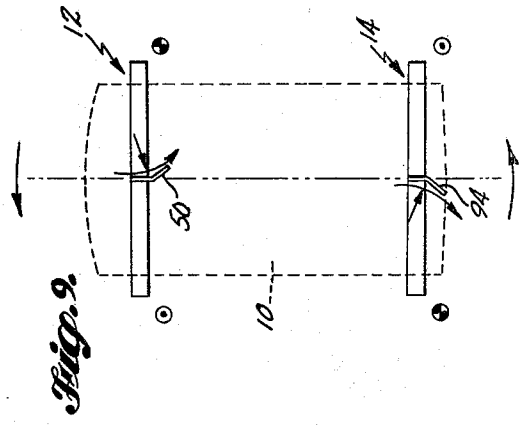

Fig. 9.

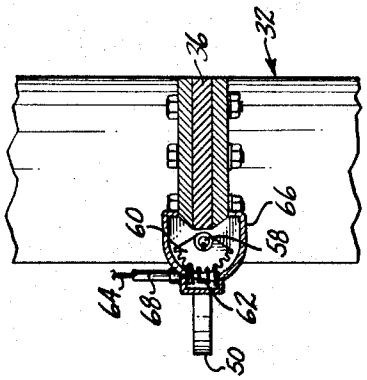

Fig. 6.

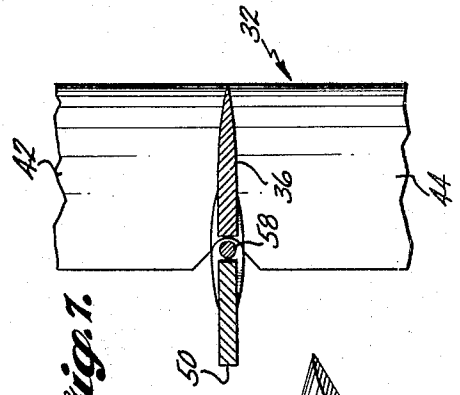

Fig. 7.

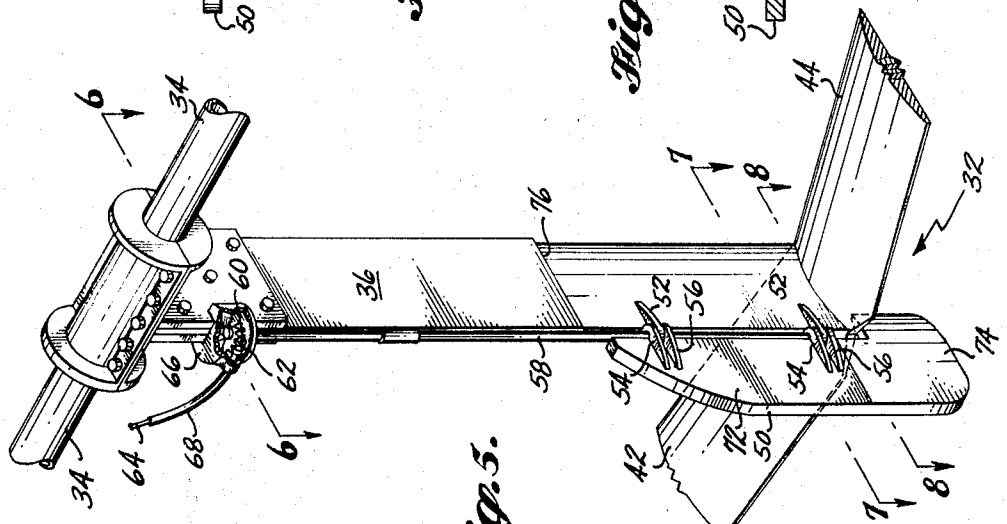

Fig. 5.

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United States Patent Office 3,294,052 Patented Dec. 27, 1966

3,294,052

STEERING MECHANISM FOR HYDROFOIL BOATS

Ted O. Jones, Kennydale, Wash., assignor to Hydro Marine Incorporated, Houghton, Wash., a corporation of Washington

Filed May 13, 1965, Ser. No. 455,460
9 Claims. (Cl. 114—66.5)

The present invention relates to hydrofoil boats, and more particularly to steering mechanism for hydrofoil boats of the type characterized generally by a displacement hull and a pair of surface piercing hydrofoils, one of which is supported below a forward portion of such hull and the other of which is supported below the stern portion of the hull, and to steering techniques involving such mechanism.

Typical hydrofoil boats of the surface piercing hydrofoil type are disclosed by: Von Schertel, U.S. Patent No. 2,720,180; Vertens, U.S. Patent No. 2,767,678; and Vertens, U.S. Patent No. 2,842,083.

Surface piercing hydrofoils have inclined, dihedrally related side portions interconneced by a substantially horizontal central portion. During "flying" of the boat only the central portions and the lower areas of the inclined side portions are normally submerged, and the main lifting force is provided by the central portions. Upon any tendency of the boat to tilt or roll about its longitudinal axis to one side, the inclined foil portions on such side are immersed more than normal and exert a stabilizing lift on the boat, tending to maintain it on an even keel.

Hydrofoil boats of the surface piercing hydrofoil type are conventionally steered by a rudder located generally at the stern of the boat, but with some difficulty. To effect a turn, the rudder is rotated in the opposite rotational sense to the desired direction of turn. The water in the path of the rudder is then turned thereby and accelerated into a new direction, creating a lateral component of force tending to swing the stern sideways in a direction opposite to the turn, and to point the bow into the turn. However, since the boat has a high center of gravity, and the rudder is offset a substantial distance below it, the water reaction force acting on the rudder causes the boat to bank into the turn. As this happens the inside inclined side portion of the forward hydrofoil becomes more submerged than usual and produces forces which oppose turning.

A principal object of the present invention is to provide a steering system operable to keep a hydrofoil boat of the surface piercing hydrofoil type on a substantially even keel while making a turn, so that no major hydrofoil interference with turning occurs.

According to the present invention, a "turning" or "steering" rudder is associated with the forward hydrofoil. In preferred form, the support structure for the forward hydrofoil includes a vertical center strut, and such rudder is journaled for rotation generally at the rear edge of such strut. To effect a turn, or to keep the boat on course when a wind or current condition exists tending to push it off course, the rudder is rotated in the same rotational sense as the desired direction of relative turn. It then produces a lateral component of force by water reaction which tends to push the bow portion of the boat relatively sideways. Since the forward rudder is located below the center of gravity of the boat, it also produces a rotational (or roll) effect tending to bank the boat away from the turn. Such banking is in part checked by the inclined portion of at least the forward hydrofoil on the outside of the turn, but only in part. According to the invention, a second or "trim" rudder is provided at the stern of the craft, at the customary location of conventional stern placed turning rudders. The trim rudder is used principally for correcting the lateral trim of

the boat. Its main purpose is to produce a rotational moment in the vertical sense which acts in opposition to, and hence counters the rotational moment produced by the forward rudder. In order to do this, it normally is rotated in the opposite rotational sense to the direction of relative rotation of the bow. Therefore, it also produces a horizontal moment tending to swing the bow relatively sideways in the desired direction. Hence, the horizontal moments produced by the two rudders are additive and both tend to rotate the boat horizontally in the same direction, whereas the vertical moments are opposite. The vertical moment produced by the forward rudder tends to roll the boat to one side, and the vertical moment produced by the rear rudder tends to roll the boat to the other side. According to the invention, turning or steering is effected mainly by movement of the forward rudder, and then, in response to a tendency of the boat to roll sideways, the rear rudder is operated so as to produce a moment that opposes the undesirable roll effect of the forward rudder.

According to this invention, a sideways rolling tendency produced by an uneven lateral distribution of passengers and/or cargo weight (i.e. more weight is situated on one side of the longitudinal axis than on the other) may also be countered by the trim rudder.

These and other features, advantages, objects and capabilities of steering equipment according to the present invention will be apparent from the following description of a typical form thereof, as adapted for use on a catamaran hull, for example, taken together with the accompanying illustrations, wherein like numerals refer to like parts, and wherein:

FIG. 1 is a perspective view of a boat hull and hydrofoil combination embodying the teachings of the present invention, with the boat hull being shown in broken lines and the hydrofoil assemblies in full line;

FIG. 2 is a side elevational view of the boat hull and hydrofoil combination of FIG. 1, with parts in section;

FIG. 3 is a cross-sectional view through the boat hull in the vicinity of the front edge of the rear rudder, taken substantially along line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view through the boat hull in the vicinity of the rear edge of the front rudder, taken substantially along line 4—4 of FIG. 2;

FIG. 5 is a fragmentary perspective view of the central portion of the forward hydrofoil assembly, showing a typical way of mounting the center strut onto the support bar of such assembly, a typical control mechanism for the rudder post, and the relationship of the forward rudder to the center strut and the central portion of the hydrofoil;

FIG. 6 is a view taken substantially along line 6—6 of FIG. 5, showing in plan the worm gear and arcuate pinion portions of the illustrated form of control mechanism for the rudder post;

FIG. 7 is a view taken substantially along line 7—7 of FIG. 5, showing the cross-sectional configuration of the portion of the forward rudder that is situated above the hydrofoil;

FIG. 8 is a view taken substantially along line 8—8 of FIG. 5, showing the manner in which the hydrofoil is cut away or notched immediately rearwardly of the center strut, so as to permit limited pivotal movement of the rudder, and showing in full line the rudder in a straight ahead position, and in broken line such rudder in both its full left turn and its full right turn position;

FIG. 9 is a somewhat diagrammatic top plan view of the boat of FIGS. 1 and 2, showing the front rudder turned so as to effect a left turn, and the rear rudder turned so as to correct the lateral trim of the boat and keep it on a substantially even keel throughout the turn;

FIG. 10 is a fragmentary side elevational view taken

in the vicinity of the mounting apparatus for the rear hydrofoil assembly, such view including a full line showing of the various components of such assembly in their in use positions, and a broken line showing of such components in their retracted positions;

FIG. 11 is a view like FIG. 10, but of the mounting apparatus for the forward hydrofoil assembly, and further including a broken line showing of the various components of such assembly in the position which they take upon the breaking of a shear pin; and

FIG. 12 is a fragmentary perspective view of an intermediate portion of the telescopic brace shown by FIG. 11, taken in the vicinity of the shear pin, and showing the shear pin spaced outwardly away from the openings provided for it.

Referring more specifically to the several figures of the drawing, FIGS. 1 and 2 show a catamaran type hull **10** equipped with a front or bow hydrofoil assembly **12** and a rear or stern hydrofoil assembly **14**. The hull **10** and both hydrofoil assemblies **12**, **14** are symmetricaly constructed about a fore and aft and vertically extending plane of symmetry *y* (FIGS. 3 and 4).

The drive assembly for the craft comprises an engine **16** located in the stern area of the hull **10**, a drive shaft **18** interconnected between the engine **16** and a transmission **20**, and a propeller shaft **21** interconnected between the transmission **20** and a propeller **22**. The propeller shaft **21** is supported near its middle and at its after end by means of bearings **24**, **26** mounted at the lower ends of support struts **28**, **30**, respectively.

The front hydrofoil assembly **12** comprises a hydrofoil **32** extending abeam of hull **10**, below the bow portion thereof. The support structure for hydrofoil **32** may comprise a horizontal support member **34** mounted so as to extend laterally through and be supported by the bow portion of the hull **10**. A center strut **36** is rigidly interconnected between the mid-portion of the support member **34** and the mid-portion of hydrofoil **32**, and a pair of side struts **38**, **40** are rigidly interconnected between the ends of support member **34** and outboard portions of hydrofoil **32**.

Hydrofoil **32** is preferably of polyhedral form. The illustrated form is shown (FIG. 4, for example) as comprising a generally horizontal or slightly dihedral central portion, composed of a pair of foil sections **42**, **44** set at a relatively low degree of deadrise (about 10°, for example), and inclined side portions **46**, **48**, each set at a relatively high degree of deadrise (about 35°, for example).

According to the present invention, a rudder **50**, herein referred to as either the forward or turning rudder, is journaled for horizontal rotation generally at the rear edge of the center strut **36**. The journaling means may comprise a pair of vertically spaced apart knuckle hinges, each including a central eye **52** projecting rearwardly from the strut **36**, and entering into a jaw formed between two corresponding eyes projecting forwardly from the leading edge of the upper portion of rudder **50**. A rudder post **58** extends through the aligned eye openings and serves as a pin for retaining the parts together. So that rotation of rudder post **58** will in turn cause rotation of rudder **50**, the rudder post **58** is affixed to the eyes **54**, **56**, and freely rotatable in the eye openings of members **52**.

The mechanism for rotating post **58** may comprise a sector gear **60** or the like affixed to the upper end of rudder post **58**, a worm gear **62** in mesh with gear **60**, and a flexible shaft **64** for rotating worm gear **62**. A gear housing **66** may be provided at the rear edge and near the top of strut **36** to provide an enclosure for the gears **60**, **62** (FIGS. 5 and 6). The upper end portion of the rudder post **58** extends through an opening provided in the bottom of such housing **66**, and the gear **60** is keyed or otherwise affixed to such upper end portion of post **58**. A flexible casing or sheath **68** for shaft **64** may lead and be joined to a side portion of the housing **66**, and the control shaft **64** may project from said sheath **68** and extend through an aperture provided in the side wall of housing **66**, and at its end be secured to an end of worm gear **62**.

As shown by FIG. 1, the flexible control shaft **64** and its sheath **68** extend from the gear housing **66** to a similar type of gear assembly (i.e, a worm gear meshing with a sector gear) serving to drivingly interconnect the flexible shaft **64** with the lower end of a steering post forming a part of a steering wheel assembly **70**.

The rudder **50** is divided generally at the level whereat the hydrofoil **32** meets the lower end of center strut **36** into upper and lower portions, designated **72** and **74**, respectively. The upper portion **72** is non-counterbalanced, i.e. its leading edge substantially coincides with the pivotal axis. The lower portion of rudder **50** extends forwardly as well as rearwardly of said rotational axis, and hence is counterbalanced. The rear edge of rudder **50**, the leading edge of the rudder's upper portion **72**, and the leading edge of the portion of strut **36** that is above the water line during "flying" may all be blunt, as illustrated. However, it is preferred that the leading edge of at least the portion of strut **36** that is in the water during "flying," and the leading edge of the rudder's lower portion **74** (which of course is also submerged during "flying"), be wedge-shaped. As illustrated by FIG. 8, for example, the side surfaces of these submerged portions curve together as they extend forwardly, and they meet at a relatively sharp acute angle. In the drawing a transition line between the two forward edge forms of strut **36** is indicated at **76**.

The rear hydrofoil assembly **14** is shown to be similar in its makeup to the forward assembly **12**. In FIGS. 1 and 3, for example, it is shown as comprising a surface piercing hydrofoil **78** composed of laterally and outwardly inclined side portions **80**, **82**, and a horizontal central portion **84** interconnected between the respective inboard ends of such side portions **80**, **82**.

The support structure for the rear hydrofoil **78** includes a horizontal support member **86** mounted so as to extend laterally through and be supported by the stern portion of the hull **10**, a vertical center strut **88**, and a pair of vertical side struts **90**, **92**. The vertical center strut **88** is rigidly interconnected between the mid-portion of support member **86** and the mid-portion of hydrofoil **78**. The vertical side struts **90**, **92** are rigidly connected at their upper ends to the ends of support member **86**, and at their lower ends to outboard portions of the hydrofoil side portions **80**, **82**.

According to the invention, a "trim" rudder **94** is journaled for horizontal rotation substantially at the rear edge of center strut **88**. The journaling means may be essentially the same as the journaling means associated with the forward hydrofoil assembly **12**, and it includes a rudder post **96**. The upper end of rudder post **96** is shown to extend into a gear housing **98** containing a worm and sector gear drive means, or the like. A flexible control line means **100** drivingly interconnects said drive means with a complementary drive means located at the lower end of a steering post forming a part of a second steering wheel assembly **102** (FIG. 1). By way of typical and therefore non-limitive example, the steering post for steering wheel assembly **102** may be tubular, and the steering post for steering wheel assembly **70** may extend concentrically therethrough, with adjacent inner and outer steering wheels **104**, **106** being provided, for the convenience of the operator.

The preferred operation of the steering mechanism will now be described. Let it be assumed that the rudders **50**, **94** are aligned with each other and with their respective support struts **36**, **88** and that the boat is traveling straight ahead. When it is desired to make a turn, steering wheel **104** is appropriately rotated in order to cause rotation of forward rudder **50** in the same rotational sense as the direction of turn. Thus, if a left or counterclock-

wise turn is to be made (FIG. 9), the rudder 50 is rotated counterclockwise. The water in the path of rudder 50 is then deflected thereby, causing a change in momentum, and a force is exerted on the rudder 50. This force is transmitted from the rudder 50 through its support structure to the bow, and moves the bow sideways into the turn. However, since the rudder is located well below the center of gravity C of the craft, the water reaction also produces a significant moment acting at a right angle to the longitudinal axis of the craft, which tends to roll the craft sideways about its longitudinal center and cause it to bank away from the turn. The inclined side portions of the hydrofoils on the outside of the turn tend to resist such rolling, but by themselves do not prevent it from occurring.

According to the present invention, after the forward rudder 50 is operated in the manner described, for effecting a turn, the rear rudder 94 is operated for the purpose of substantially keeping the boat level or on an even keel throughout the turn. Referring again to FIG. 9, rotation of the rudder 94 in the opposite rotational sense to the desired direction of turn causes it to produce a horizontal rotational force by water reaction that is additive to the horizontal rotational force produced by the turning rudder 50. Thus, when turned in this direction the rear rudder 94 aids the forward rudder 50 in causing the boat to turn horizontally. However, since like rudder 50 it too is spaced a substantial distance below the center of gravity C, rudder 94 also produces a moment acting at a right angle to the longitudinal center of the craft, but in the opposite direction to the roll producing moment created by rudder 50. Thus, rudder 94 may be used for producing a moment that will oppose or counter the roll effect of the forward rudder 50. According to the present invention, it is used primarily for this purpose; the assistance it gives to rudder 50 by way of pushing the stern sideways so as to swing the bow into the turn is secondary. The operator moves rudder 50 for causing the boat to turn. Then in response to the tendency of the boat to roll, caused by rudder 50, he moves rudder 94 to prevent roll.

In FIG. 9, vertical arrow symbols (i.e. a circle with a dot in it representing upward movement and a circle with a cross in it representing downward movement) are used for indicating the direction of sideways roll tendency produced by the front and rear rudders 50, 94, respectively.

In addition to turning, the forward rudder 50 is used for steering in general. For example, it is used for the purpose of maintaining the boat on a desired course when there is a wind or current condition present tending to push it off course. The rudder 50 is rotated horizontally an amount sufficient to cause a lateral component of force by water reaction of a sufficient magnitude to hold the bow substantially on course. The boat is not actually rotated (horizontally) into a new direction, as in a turn, but it is continuously being rotated relative to the direction of wind or current travel. As during turning, the horizontal moment is attended by a vertical moment tending to roll the boat sideways. Also as during turning, the stern rudder 94 is operated in response to this rolling tendency for the purpose of countering it and maintaining proper lateral trim of the boat. The stern rudder 94 may also be used for maintaining the desired lateral trim of the boat when the tendency for the boat to roll sideways is due at least in part by other causes, such as an uneven lateral distribution of passenger and/or cargo weight, for example.

As illustrated by FIGS. 5, 7 and 8, for example, the rear edge of strut 36 and the rudder post 28 are both spaced forwardly of the rear edges of hydrofoil sections 42, 44. The sections 42, 44 are notched in the vicinity of the rear edge of strut 36 so as to make it possible to turn the rudder. In the illustrated arrangement the notch is in the form of about a ninety degree (90°) V-cut, with about half of such cut located on each side of strut 36.

As perhaps best shown by FIGS. 1 and 2, the propeller 22, and the forward part of the lower portion of rudder 94 both extend below the central portion of the rear hydrofoil 78. As a consequence, the hydrofoil acts as a cavitation plate for both of these elements, and no additional or independent cavitation plate means (not a part of the hydrofoil 78) is necessary. The midportion of the forward hydrofoil 32 also serves as a cavitation plate for the leading part of the lower portion 74 of rudder 50.

Tests which I conducted emperically showed that a boat equipped with surface piercing hydrofoils can be turned much easier by means of a forward rudder in place of a conventional stern rudder, and that turning is further improved when a stern rudder is used in conjunction with a forward turning rudder for keeping the craft substantially on an even keel throughout the turn. Another advantage of the forward turning rudder is that it operates on substantially clean water. The lower, submerged portion of strut 36, the inboard end portions of hydrofoil sections 42, 44, and its own leading edge, are the only parts associated with the boat that can cause water disturbance ahead of rudder 50, and each of these parts has a knife-like leading edge and a slim profile so that it will cut through the water and produce essentially no turbulence. This is not the case with a conventional stern located turning rudder, as it is located in the prop wash which is very turbulent water.

Preferably, the hydrofoil assemblies 12, 14 are retractably mounted so that they can be swung upwardly into substantially horizontal, out of the way, retracted positions, to facilitate handling and transporting of the boat when out of the water. As previously described, the support member 34 of the forward hydrofoil assembly 12 extends transversely through the bow portion of the hull 10, and the horizontal support member 86 for the rear hydrofoil assembly 14 extends transversely through the stern portion of the hull 10. The members 34, 86 may be mounted for rotation by means of bearings 108, 110, respectively (FIGS. 3 and 4).

The assemblies 12, 14 are provided with separate releasable means for bracing them against movement. The bracing means for the forward hydrofoil assembly 12 may comprise a lever arm 112 rigidly secured to member 34 and arranged to depend downwardly therefrom when the assembly 12 is in its position of use. An anchor 114 is affixed relative to hull 10 and spaced rearwardly of, and in substantial alignment with, the lever 112. A telescopic brace 116 is rigidly interconnectable between the lower end of lever 112 and the anchor 114, to support or brace the assembly 12 against pivotal movement. In FIG. 11, the telescopic brace 116 is shown to comprise a tubular outer section 118 and an inner section 120 telescopically received therein. Aligned openings are provided through the side walls of outer section 118, and a pair of transverse openings are formed in the inner section 120 at axially spaced locations. The first of the openings in section 120 is positioned such that when it is put in alignment with the openings in outer section 118, the support struts 36, 38, 40 are substantially vertical, and the hydrofoil 32 is properly oriented for use. When the second opening in section 120 is aligned with the openings in section 118, the struts 36, 38, 40 are substantially horizontal. A locking pin 122 is used for locking the sections 118, 120 together.

When it is desired to move the forward hydrofoil assembly from its in use to its retracted position, the locking pin 122 is removed and the assembly 12 is swung forwardly and upwardly until the second opening in inner section 120 of the telescopic brace 116 is aligned with the openings in the outer section 118. The pin 122 is then inserted through this new set of aligned open-

ings, and when in place it serves to lock the forward assembly **12** in its retracted position (FIG. 11).

Pin **122** is designed so that it will shear and permit a rearward collapse of the forward hydrofoil assembly **12** in the event such assembly encounters an obstruction in the water. Of course, the pin **122** is designed so that it will withstand the forces put on it by minor obstructions, and to shear when such obstructions are sufficiently large enough that damage of the hydrofoil assembly **12** would be likely. When pin **122** is sheared, the hydrofoil assembly **12** swings rearwardly (FIG. 11) and the inner section **120** of brace **116** moves further into the outer section **118**. As best shown by FIG. 4, the lever arm **112**, the anchor **114** and the telescopic brace **116** may all be located in one of the two hull parts of the boat, if a catamaran hull is involved, as illustrated.

FIG. 11 presents a solid line showing of the in use position of components **112**, **116**, **38**. The normal retracted position is shown in broken lines immediately above the solid line showing, and the rearward retracted position (occurring when pin **122** is sheared) is shown in broken lines at the top of the figure.

Support member **86** for the rear hydrofoil assembly **14** is provided with a lever **124** arranged to project upwardly above the member **86** when the hydrofoil assembly **14** is down in its in use position. An anchor **126**, affixed relative to the hull **10**, is located forwardly of and in line with the lever **124**, and a telescopic brace **128** is rigidly interconnectable between the upper end of lever **124** and the anchor **126**. Like brace **116**, the brace **128** includes a tubular outer section **130**, an inner section **132**, and such sections are lockable together by means of a pin **134**, insertable through aligned openings in the outer section **130** and a selected one of a pair of axially spaced openings formed in the inner section **132**. In the illustrated embodiment, when the pin **134** is located in the forward opening in section **132**, the hydrofoil assembly **114** is in its normal position of use. When the pin **134** is in the rear opening in section **132**, the assembly **14** is swung rearwardly and upwardly from its position of use, into a generally horizontal retracted position (FIG. 10). Pin **134** also functions as a shear pin and is designed to break when the submerged portions of hydrofoil assembly **14** encounter obstacles capable of producing destructive forces.

In FIG. 10, the in use position of components **90**, **124**, **128** is shown in the upper portion of the view by solid lines. The retracted position is presented below such showing, in broken lines.

The forwardly located turning rudder feature of the present invention is not limited to use on a central strut, but may also be used on one or both of a pair of intermediate struts, such as those shown by FIG. 2 of the aforementioned Vertens U. S. Patent No. 2,767,678, for example. The trim rudder at the stern of the craft may also be provided on one or both of a laterally spaced pair of intermediate struts. Furthermore, application of the present invention is not at all limited to a catamaran type hull, but rather the forward turning rudder, and such rudder in combination with an after trim rudder, may be advantageously employed with other types of hulls, such as a conventional vee, shallow vee or rounded bottom hull, or a trimaran hull, for example. Also, a hydraulic or electrical control system leading from the steering wheel assemblies to the drive means at the upper ends of the respective rudder posts may be employed in place of the mechanical drive system that is illustrated. The only requirement in an installation wherein the front and rear hydrofoil assemblies are retractable, is that the control line means be flexible and of such a length that they remain slack during movement of the hydrofoil assemblies between their respective in use and retracted positions.

The foregoing is to be considered as being merely illustrative of typical structural embodiments incorporating the principles of the present invention, and is therefore to be construed as not limitive in nature. Since changes, variations, and modifications in the form, construction and the arrangement of the steering mechanism shown and described may be had without departing from the spirit of the invention, it is to be understood that the invention is to be limited solely by the scope of the appended claims.

What is claimed is:

1. A water craft comprising: an elongated hull; front and rear hydrofoil assemblies, each comprising a transverse hydrofoil spaced below the hull, and including a relatively flat central portion and surface piercing side portions extending both upwardly and laterally outwardly from and on opposite sides of said central portion, and support structure for said hydrofoil interconnected between said hydrofoil and the hull, with at least the support structure for the forward assembly including a substantially vertical strut disposed below the hull, and a turning rudder having a forward portion journaled for horizontal rotation generally at the rear edge of said strut, with at least a greater portion of said rudder being disposed rearwardly of the rear edge of said strut; and propulsion means for said craft situated rearwardly of said front hydrofoil assembly.

2. A water craft comprising: a displacement hull symmetrically constructed about a fore and aft and vertically extending plane of symmetry; front and rear hydrofoil assemblies respectively situated forwardly and rearwardly of the center of gravity of said craft, and each comprising a transverse hydrofoil spaced below the hull, and including a relatively flat central portion and surface piercing side portions extending both upwardly and laterally outwardly from and on opposite sides of said central portion, and support structure for said hydrofoil interconnected between said hydrofoil and the hull, with at least the support structure for the forward assembly including a substantially vertical strut located in said lane of symmetry, and a rudder having a forward portion journaled for horizontal rotation generally at the rear edge of said strut, with at least a greater portion of said rudder being disposed rearwardly of the rear edge of said strut; and propulsion means for said craft situated rearwardly of said front hydrofoil assembly.

3. A water craft comprising: a displacement hull symmetrically constructed about a fore and aft and vertically extending plane of symmetry; front and rear hydrofoil assemblies respectively situated forwardly and rearwardly of the center of gravity of said craft, and each comprising a transverse hydrofoil spaced below the hull, and including a relatively flat central portion and surface piercing side portions extending both upwardly and laterally outwardly from and on opposite sides of said central portion, support structure interconnected between said hydrofoil and the hull and including a substantially vertically intermediate strut extending below the hull, and a rudder having a forward portion journaled for horizontal rotation generally at the rear edge of said strut, with at least a greater portion of said rudder being disposed rearwardly of the rear edge of said strut; and drive means for said craft including a propeller situated substantially immediately forward of and in line with the rear rudder, and substantially rearwardly of said front hydrofoil assembly.

4. A water craft comprising: a catamaran hull having a central tunnel area; front and rear hydrofoil assemblies respectively situated forwardly and rearwardly of the longitudinal center of said hull, and each comprising surface piercing hydrofoil means spaced below the hull, and support structure interconnected between said hydrofoil means and the hull, with at least the support structure for the forward assembly including a substantially vertical center strut, means mounting the upper end of said strut on the hull, in the vicinity of the tunnel roof, at the center of said tunnel, and a rudder journaled for horizontal rotation immediately rearwardly of said strut; and means for propelling the craft forwardly.

5. In a water craft of a type comprising a catamaran hull having a longitudinally extending, laterally arched, central tunnel area formed between a pair of hull parts; surface piercing hydrofoil means for hydrodynamically lifting such hull out of the water during forward acceleration of the craft, and for hydrodynamically supporting such hull in a position above the water during cruising at high speed travel of the craft, said hydrofoil means including a bow section hydrofoil assembly comprising a hydrofoil member spaced a substantial distance below and extending abeam of said hull, and support structure interconnected between said hydrofoil member and the hull, said support structure including a center strut and a pair of outboard struts; a rudder journaled for horizontal rotation substantially immediately rearwardly of the center strut; control means for rotating said rudder; means mounting said hydrofoil assembly for pivotal movement between a position of use wherein the struts are substantially vertical, and a retracted position wherein said struts are substantially horizontal and the center strut is located in the tunnel, between the hull parts, and means normally locking the hydrofoil assembly in its in use position.

6. The combination of claim 5, the rudder control means including a rudder post extending generally vertically in line behind said center strut above the rudder, and being attached to said rudder, and means for rotating said rudder post comprising drive means mounted on said center strut, near the upper end thereof, operator control means, and a flexible control line means interconnected between said operator control means and said drive means, and being of a sufficient length and flexibility to permit it to remain slack during movement of the hydrofoil assembly between its in use and retracted positions.

7. A water craft comprising: an elongated hull; front and rear hydrofoil assemblies, each comprising a surface piercing hydrofoil means spaced below the hull, and support structure for same interconnected between said hydrofoil means and the hull, with at least the support structure for the forward assembly including a substantially vertical strut disposed below the hull, and a turning rudder journaled for horizontal rotation generally at the rear edge of said strut, and including a non-counterbalanced upper portion extending above said hydrofoil means and a counterbalanced lower portion depending downwardly below the level of said hydrofoil means at the strut; and propulsion means for said craft situated rearwardly of said front hydrofoil assembly.

8. A water craft comprising: a displacement hull symmetrically constructed about a fore and aft and vertically extending plane of symmetry; front and rear hydrofoil assemblies respectively situated forward and rearwardly of the center of gravity of said craft, and each comprising a surface piercing hydrofoil means spaced below the hull, and support structure for same interconnected between said hydrofoil means and the hull, with at least the support structure for the forward assembly including a substantially vertical strut located in said plane of symmetry, and a rudder journaled for horizontal rotation generally at the rear edge of said strut, and including a non-counterbalanced upper portion extending above said hydrofoil means and a counterbalanced lower portion extending downwardly below the level of said hydrofoil means at the strut; and propulsion means for said craft situated rearwardly of said front hydrofoil assembly.

9. The combination of claim 8, wherein at least that portion of the strut disposed immediately forwardly of the upper portion of the rudder, and the lower portion of the rudder, each include side surfaces which curve together and meet at a relatively sharp acute angle, giving such portions a relatively sharp leading edge.

References Cited by the Examiner

UNITED STATES PATENTS

1,529,036	3/1925	Richey	114—66.5
1,780,767	11/1930	Scott-Paine	114—163
2,720,180	10/1955	Von Schertel	114—66.5
2,791,195	5/1957	Almiquist et al.	114—66.5
3,137,260	6/1964	Harris et al.	114—66.5

FOREIGN PATENTS

1,157,956	11/1963	Germany.

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