RUDDER FOR MARINE VESSELS

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This invention relates to improvements in rudders for ships and boats of the multiscrew type and more particularly concerns a modified rudder assembly operable with a high degree of effectiveness with the vessel at a standstill or moving at low speeds, as well as under cruising conditions. The invention is herein illustratively described by reference to the presently preferred embodiment thereof; however, it will be recognized that certain modifications and changes therein with respect to details may be made without departing from the essential features hereof.

While the invention is not limited in its application to ships (i.e., large vessels), it is in this particular field that conventional rudders, even in a multiscrew vessel, present the greatest problem of control. At very low speed or at a standstill, a rudder is ineffective only when impinged by the propeller wash. In a large vessel of conventional rudder design, transverse offset of the propellers from the rudder plane prevents the propeller wash from reaching the rudder even in its most hard-over position. Consequently, such vessels do not answer the helm when at standstill or moving at low speeds.

An object of this invention is to devise a rudder solving this problem without unduly increasing the cost of the rudder system, complicating the rudder mount, or overloading the rudder actuating mechanism or rudder mount. Another object is to achieve these results without imposing serious drag or otherwise impairing efficiency of the vessel under cruise conditions. A related object is to achieve the aforementioned ends in a manner readily adaptable to conversion of existing conventional rudder installations and without necessity for expensive modifications thereof in order to incorporate the working principles of the invention therein. Further, the invention makes possible inherent compensation for any additional weight load imposed on the rudder bearings or rudder actuator. Such compensation may be attained where desired through buoyancy of the elements added to the conventional rudder or through hydrodynamic lift effort achieved from such elements.

Moreover, the improved rudder systems provided by this invention also lend themselves to partially balanced rudder designs. That is, reaction torque as a source of load on the rudder actuator mechanism may be offset inherently to essentially the same degree and effect as can be achieved with conventional rudders.

While rudders incorporating elements of this invention employ companion foils so mounted and movable that they interact with the propeller wash at all speeds, these foils are mounted in essentially parallel relationship so as to function both when in trim and when in turned positions as the main rudder itself. That is, the main rudder and companion foils are hydrodynamically independent of each other. The companion foils of the present invention, therefore, are not to be compared with and do not function as diversifiers or flow directors angled to the main rudder in order to maintain laminar flow past the main rudder by directing water angularly against the face of the main rudder. Previously contemplated devices of that nature were intended to prevent stalling and consequent drag loss when the rudder is turned to a hard-over position. However, in the dead-ahead position of the rudder assembly drag losses of angled foils present a problem under cruise conditions. Such drag losses are avoided with the present invention; moreover, placement and arrangement of the companion foils herein makes for a more effective rudder action at all speeds, so that rudder turn angle may be kept sufficiently small to avoid rudder stall.

With this invention, companion rudders are mounted in parallel relationship at respectively opposite sides of the main rudder or equivalent support and in the trim position lie in or substantially at the edge of the wash from the respective outboard screws usually located forward thereof. These foils are preferably symmetrical in longitudinal cross section. However, being set with their leading edges forward of the pivot axis of the rudder assembly, any turning of the assembly by movement of the rudder actuator causes the outboard foil (i.e., on the outside of the commanded turn) to reach further into the slipstream from the outboard screw and thereby develop maximum reaction torque therefrom even with the vessel at a standstill. Thus, a characterizing feature of the improved rudder assembly is the retention or increase of interception area presented by the outside companion foil as a function of increased turning angle of the rudder assembly. Moreover, such forward offset of the leading edge of the foil in relation to the rudder may be so chosen that any selected degree of self energization effect may be achieved with this modified rudder as with conventional rudders.

Horizontal support fins which mount the companion foils on respective opposite sides of the main rudder may be utilized, by their angle of attack, to achieve any desired hydrodynamic lift effect offsetting rudder weight imposed upon the rudder bearings. These and other features, objects and advantages of the invention will become more fully evident from the following description thereof to reference to the accompanying drawings.

FIGURE 1 is a perspective view of the illustrated embodiment of the modified rudder assembly.

FIGURE 2 is a side elevational view of a ship's stern in which the modified rudder assembly is installed, the rudder assembly being shown in the dead-ahead position.

FIGURE 3 is an end view of the modified rudder assembly.

FIGURE 4 is a horizontal sectional view taken approximately on line 4-4 in FIGURE 2 in order to illustrate positional relationships of the companion foils with the main rudder and the outboard propellers in both the trim position (dotted lines) and in the hard-over position (solid lines).

In the drawings the main rudder 10 may be of conventional form, mounted on an upright rudder shaft 12 and adapted to be turned by suitable or conventional actuator mechanism (not shown). The rudder is customarily mounted at the stern of the hull H at a central location midway between the outboard locations of the screws or propellers 14 and 16 and in alignment with the keel. Such a rudder is symmetrical about its longitudinal midplane and is of streamlined (canted) configuration as to impose minimum drag. Usually its forward edge 18a is located ahead of the turning axis A to some extent so as to achieve a desired degree of self energization or balance. By the term "self energization" reference is made to utilization of water reaction force on the portion of the rudder surface projecting forwardly from the turning axis to offset or partially offset the water reaction force upon the rudder surface projecting aft from the turning axis.

In accordance with this invention the main rudder 10 serves as a rudder and is subjected to essentially the same water flow conditions and reacts thereto essentially with the same effect as it does in conventional installations wherein it functions alone. However, here, in the preferred embodiment, it also serves as a physical support and
locator for the companion foils 18 and 20. These foils are mounted at respectively opposite sides of the main rudder in laterally displaced positions. In FIGURES 3 and 4 the propeller tip circles C1 and C2 are spaced laterally outward from the longitudinal plane P containing axis A by approximately the same distance as the respective companion foils 18 and 20. Thus, in the dead ahead position of the rudder assembly wherein the foils are parallel with the plane P, the companion foils lie substantially at the edges of the respective propeller washes. These companion foils can be fabricated and preferably are streamline and symmetrical about their longitudinal midplane. Consequently, these foils create minimal drag and in fact add to longitudinal stability of the vessel when in trim position. As previously stated, each of the companion foils 18 and 20 and the main foil 10 acts separately in relation to the incident stream and neither depends hydrodynamically upon the other for its function.

Being positioned as they are, substantially in the vicinity of the rearward extension of the tip circles of the respective propellers 14 and 16, with the rudder assembly in trim, most of the wash from the propellers moves past these companion foils just as it moves past the main rudder 10, although, of course, the velocity of water in the vicinity of the companion foils will necessarily be slightly greater than it is at the main foil 10. However, with the leading edges of the respective companion foils disposed relatively to the rearward extension of the turn of the rudder assembly causes the companion foil on the outside of the turn to move laterally outward and further into the propeller wash. This result obtains from the fact that the arc of swing carries the leading edge in an outboard direction and therefore farther forward of an extended tip circle of the propeller, plus the fact that the wash itself somewhat diverges rearwardly from the propeller. Consequently, the companion foil has much greater effect to develop lateral reaction force than does the main foil 10 even though the companion foil may be a fraction the size of the main foil. On the other hand, since the companion foils are located preferably at or near the edges of the propeller washes, the water speed incident upon them under cruise conditions is not a great deal higher than that incident on the main rudder, so that they do not impair cruise efficiency but may, in fact, improve it to a slight degree by the collimation effect which they afford.

While various methods may be used to support the companion foils 18 and 20 in the described positional relationship with the main rudder and the propellers, it is preferred to employ horizontally disposed fins 22 and 24 projecting therefrom and thereby extending in front of the respective longitudinal planes of the main rudder 10 at respective locations along its lower edge and near its top or intermediate its top and bottom. In these positions the supporting fins 22 and 24 minimize tip eddying along the companion foils 18 and 20, and thereby improve their hydrodynamic efficiency as rudder foils. Flow through the regions between the main rudder 10 and the respective companion foils 18 and 20 is thereby more efficiently collimated as a result of the supporting fins. These supporting fins may be of hollow, water-tight construction as may be the companion rudder foils 18 and 20, thereby creating a certain degree of buoyancy which at least partially offsets the weight of the added components attached to the main rudder. Consequently, the resultant load on the rudder need be no greater than conventional and may even be less than conventional. Furthermore, because in the case of certain hull forms such as that shown, in which water flow moves rearwardly and upwardly along the stern, positioning of the supporting fins 22 and 24 along the respective horizontal planes results in a hydrodynamic lift effect derived from these fins due to the angle of incidence of the water flow thereon. With other hull forms the fins 22 and 24 may be sloped if desired to create an angle of attack achieving lift effect. This further lessens downward load exerted on the rudder bearings (not shown).

Depending upon the length of the companion foils 18 and 20 fore and aft, and the degree to which they project forwardly from the transverse plane of the rudder axis A, any desired degree of partial self energization of the rudder assembly may be achieved to either augment or to lessen the degree of self energization achieved from the main rudder 10.

These and other aspects of the invention will be evident to those skilled in the art based on the foregoing description of its presently preferred form.

I claim as my invention:

1. A multifoil rudder assembly for a marine vessel having propellers mounted at locations spaced laterally outward from respectively opposite sides of a longitudinal vertical plane of the vessel, comprising a main rudder having a supporting shaft by which the main rudder is mounted to pivot on a substantially vertical axis contained in said plane, and companion foils, each of a shape that produces a neutral hydrodynamic effect as between its opposite faces, carried by and in parallel relationship with said main rudder at respective locations spaced laterally outward from opposite sides of the main rudder each by a distance which approximates the spacing between said plane and the tip circles of the respectively adjacent propellers, whereby the foils when positioned parallel to said plane lie substantially at the edges of the respective propeller washes, said companion foils having their leading edges offset forwardly from the pivot axis, whereby when the foils are turned about said axis the leading edge of one such companion foil is projected rearwardly and more deeply outwardly into the adjacent propeller wash to afford maneuverability apart from any afforded by the rearwardly projected mechanical rudder foils.

2. The multifoil rudder assembly defined in claim 1, including generally horizontal supporting fins mounted on respectively opposite sides of the main rudder and projecting outwardly therefrom to carry the companion foils, there being at least two supporting fins on each side of the main rudder in vertically spaced relationship.

3. The multifoil rudder assembly defined in claim 2, wherein the supporting fins comprise foils connecting the lower edges of the respective companion foils with the lower edge of the main rudder, and foils spaced upwardly therefrom.

4. The multifoil rudder assembly defined in claim 1, wherein the companion foils comprise hollow, water-tight streamlined forms having buoyancy which exerts lift on the rudder assembly.

5. The multifoil rudder assembly defined in claim 1, wherein the companion foils extend forwardly and rearwardly by approximately equal distances from a transverse plane containing said pivot axis and lying perpendicular to said longitudinal plane.

6. The multifoil rudder assembly defined in claim 5, wherein the companion foil portions extending forwardly from said transverse plane subtend a horizontal angle of the order of thirty degrees from the pivot axis.
A multifoil rudder assembly for a marine vessel having propellers mounted at locations spaced laterally outward from respectively opposite sides of a longitudinal vertical plane of the vessel, comprising a supporting shaft by which the rudder assembly is mounted to pivot on a substantially vertical axis contained in said plane, and companion foils carried by said shaft and in parallel relationship at respective locations spaced laterally outward from opposite sides of said shaft, each by a distance which approximates the spacing between said plane and the tip circles of the respectively adjacent propellers, whereby the foils when positioned parallel to said plane lie substantially at the edges of the propeller washes, said companion foils having their leading edges offset forwardly from the pivot axis whereby the foils when turned about said axis of said parallel position the leading edge of one such companion foil projects rearwardly and more deeply outwardly into the adjacent propeller wash.

The multifoil rudder assembly defined in claim 7, wherein the companion foils extend forwardly and rearwardly by approximately equal distances from a transverse plane containing said pivot axis and lying perpendicular to said longitudinal plane.

A multifoil rudder assembly for a marine vessel having propellers mounted at locations spaced laterally outward from respectively opposite sides of a longitudinal vertical plane of the vessel, comprising two generally upward foils spaced laterally outward from opposite sides of said plane in respective positions lying substantially at the edges of the washes from the respectively adjacent propellers, said foils being of generally planar form, and disposed in parallel relationship, and means mounting said foils for turning conjointly about a substantially vertical axis contained in said plane, said axis being disposed in a transverse plane lying perpendicular to said first mentioned plane and intersecting the respective foils intermediate their forward and rearward edges.

The multifoil rudder assembly defined in claim 10, wherein the transverse plane intersects the respective foils approximately midway between their forward and rearward edges.

Among the references cited by the Examiner:

UNITED STATES PATENTS
2,043,276 6/36 Weltons 114-162
2,972,523 2/61 Einarsson et al. 114-162

FOREIGN PATENTS
411,564 3/25 Germany

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