Sept. 16, 1969 W. BRÖHL 3,467,045

SHIP'S RUDDER

Filed Dec. 27, 1967 4 Sheets-Sheet 1

FIG.1

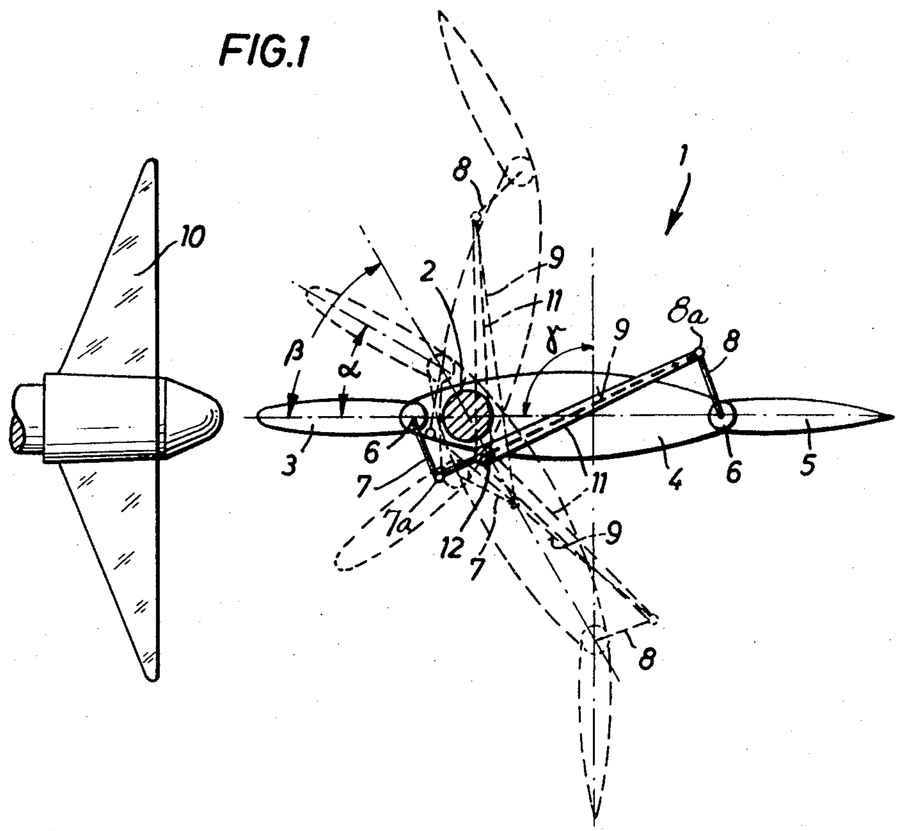

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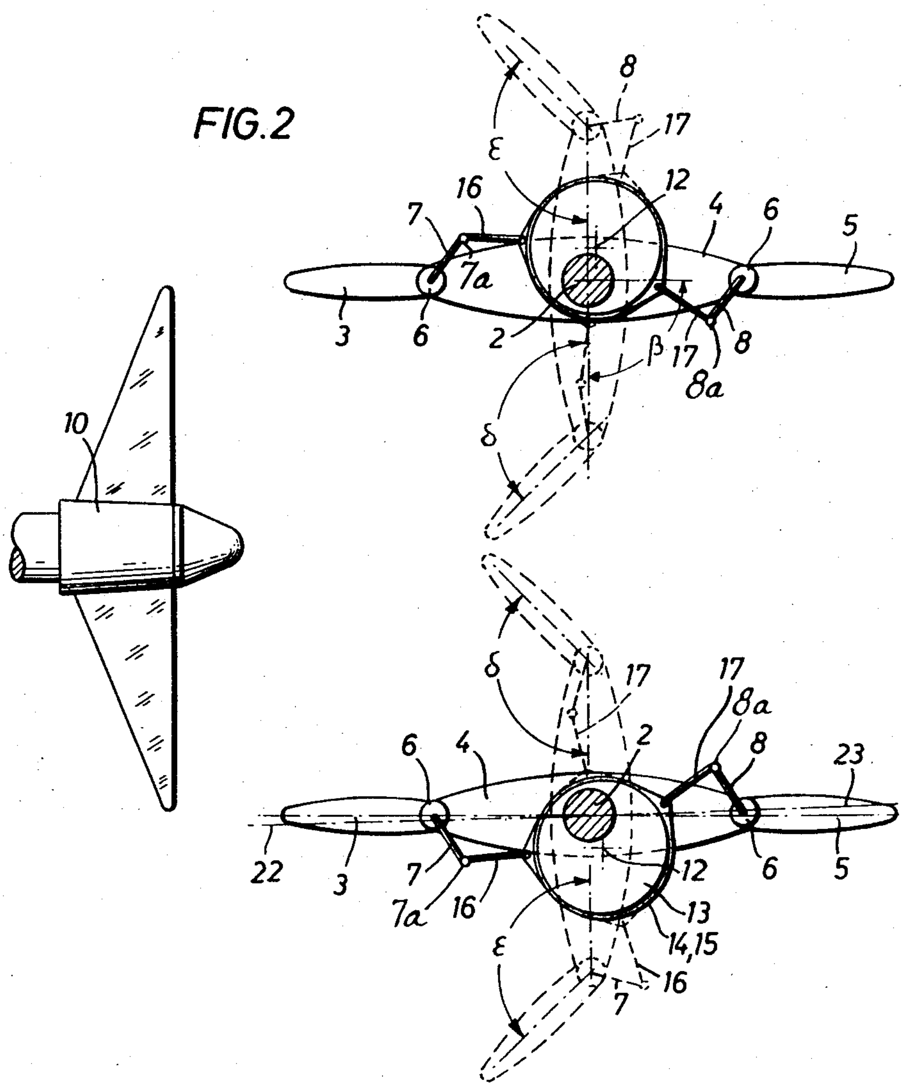
FIG. 2



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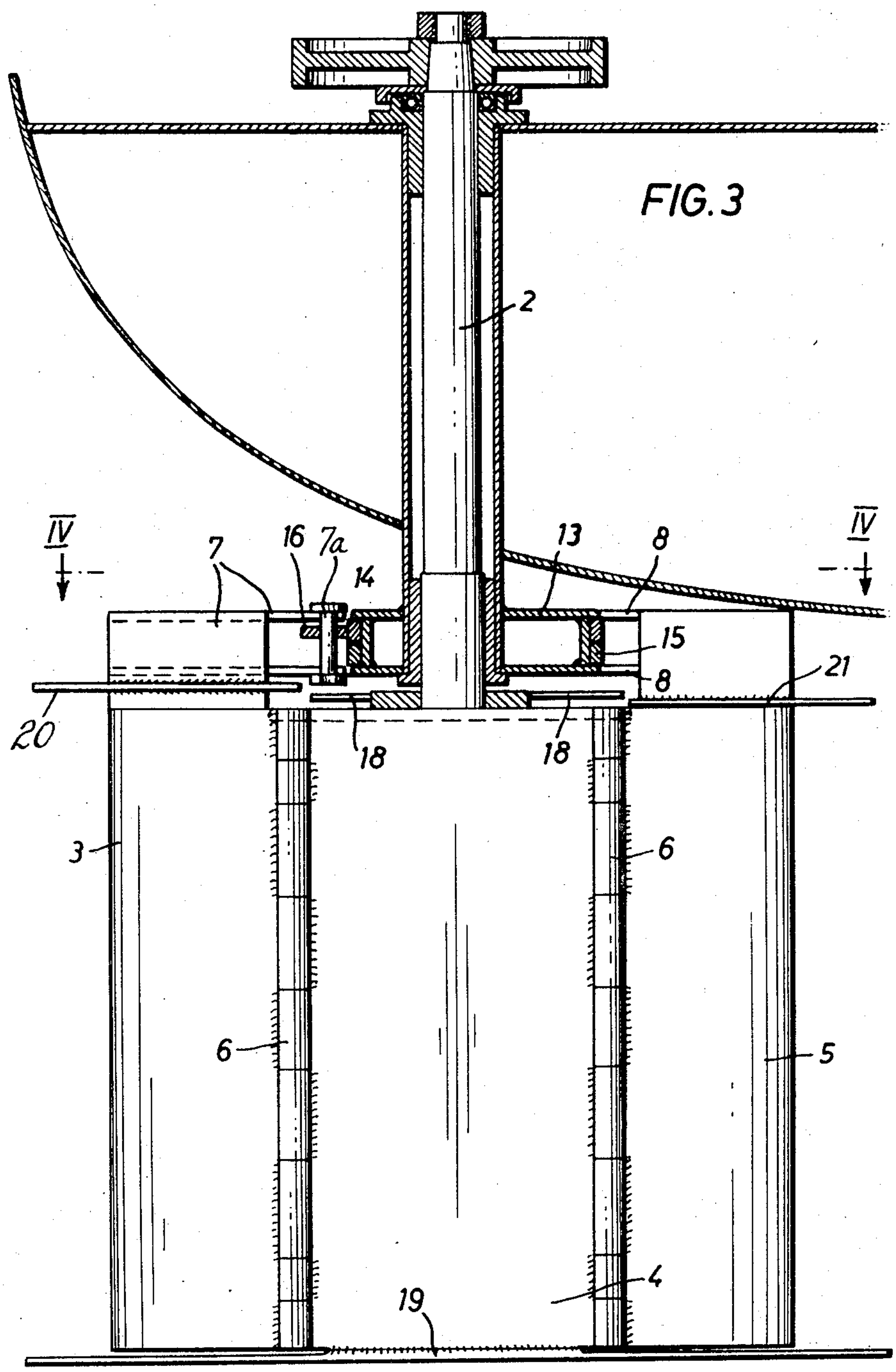

FIG. 3

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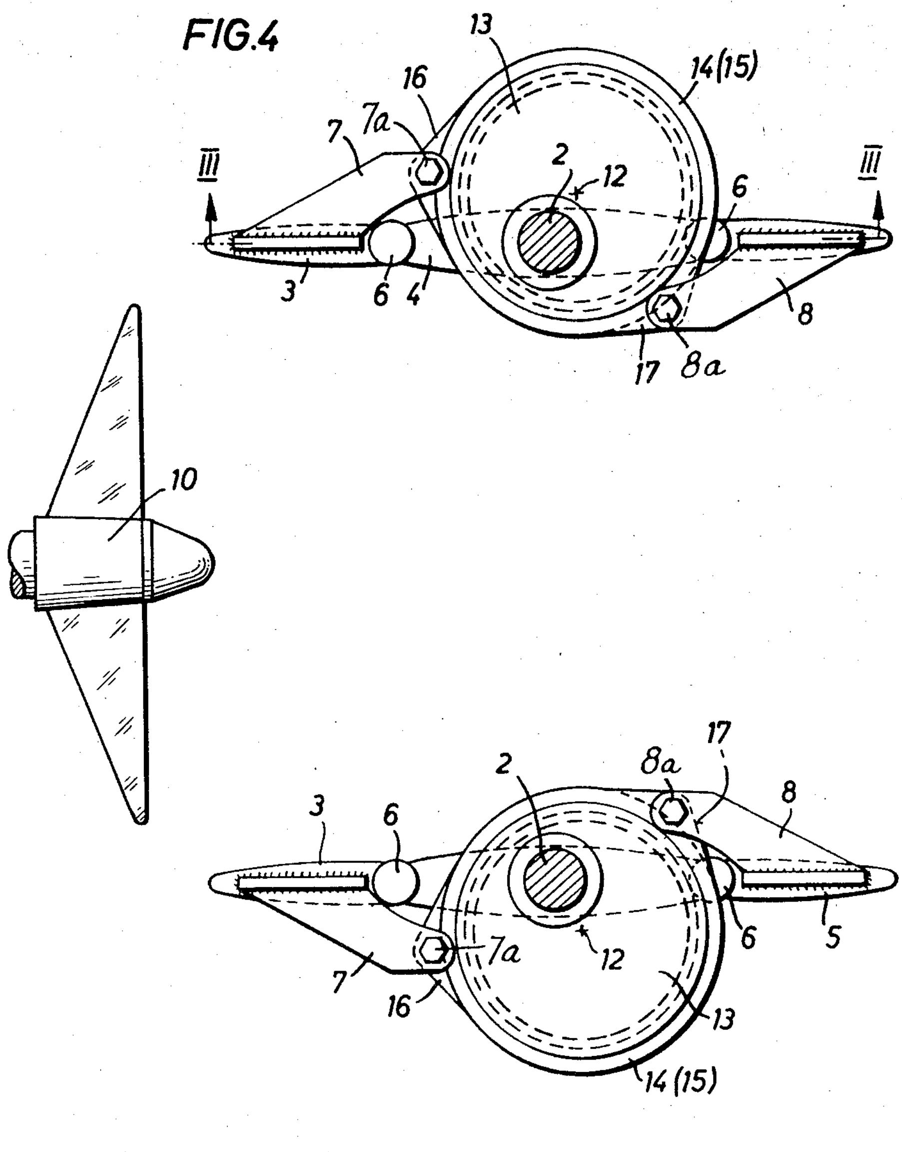
Sept. 16, 1969 W. BRÖHL 3,467,045

SHIP'S RUDDER

Filed Dec. 27, 1967 4 Sheets-Sheet 4

FIG.4



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SHIP'S RUDDER

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U.S. Cl. 114—167 14 Claims

ABSTRACT OF THE DISCLOSURE

This ship's rudder includes fins which are mounted at the ends of a main rudder which is rotatably mounted between the ends thereof.

Background of the invention

In rudder installations attempts are made to counteract thrust in the hard-over position and to change it into transverse thrust, so that turning circles are satisfactory. With large rudder deviations there is less conversion of forward into transverse thrust than an actual counteraction of the former by braking. In this connection attempts are made with multi-surface installations to improve the deflection of the current by a determined positioning of the surfaces relative to one another. Yet the ratio of forward to transverse thrust remains small. It has already been proposed, in the case of a relatively small positioning of the rudder in the current, to make use of the forward thrust essentially for transverse power by providing the main rudder with a connected, steerable fin. On deflection of the rudder through a certain angle, the fin is to be moved by double the said angle to the ship's longitudinal plane, so as to be able to deflect the current. Reasonable results of this formation of the fin-rudder are, however, only obtained when the leading edge of the main rudder is made considerably larger than normal. It thus reaches a greater length than the distance between the rotary axis of the main rudder and the pivot point of the fin. Even in this single-surface fin-rudder the degree of conversion of thrust from forward into transverse is restricted.

Summary of the invention

The object of this invention is to increase the efficiency of the fin-rudder into a high performance rudder by keeping the motive power for the rudder at a minimum and making short steering times possible.

The ship's rudder constructed according to the invention includes a pivotable main rudder having a fin pivotally joined at each end thereof. When the main rudder is turned, the fins pivot to the same side as the main rudder and in the direction of the ship's screw. The rotary axes of the pivotal fins can be connected by a rod running diagonally to the main axis of the rudder. This connection may include guides which are rigidly connected to the fins at the said rotary axes. A steering arm fixedly attached at one end thereof to the stern engages with a guide at the other end.

By means of such formation of the rudder, high steering transverse thrust values are attained for small rudder movements. High steering performances, even at low speeds, are achieved. Even with slight positioning of the fin-rudder according to the invention, high transverse

thrust values are released, the steersman's effort being kept down. The extensive conversion of forward to transverse thrust allows a high degree of efficiency. The ship answers sensitively to even a slight movement of the rudder. Extremely tight turning-circles can be made. In extreme cases turning on the spot is possible. Further, side-rudders, which are a particular hindrance in canal navigation, can be dispensed with. In the case of a twin rudder, turning of the ship and simultaneous reversing can be carried out. Slight movement of the rudder stems to port or starboard release corresponding transverse thrust without turning the rudder through the arc from hard port to hard starboard, as was previously necessary.

The steering rod in the twin-fin main rudder includes a fixed disc mounted on the stationary axis of the main rudder. A rotatable ring is set around the fixed disc and rod parts extend from the ring to the fins located at the ends of the main rudder. The fixed disc is transfixed by the king-pin for the main rudder. In this way, the entire ship's rudder can be rotated through 360 degrees. This necessarily includes both of the fins as well as the main rudder structure.

Another embodiment for the twin-fin main rudder includes two separate rotatable rings set around the fixed disc wherein a rod part extends from each separate ring to a fin located at one end of the main rudder. In this way each fin is separately linked to its own particular rotatable ring. A main rudder having two linked and steerable fins can be mounted on both sides of the longitudinal axis of the screw.

In this way a highly effective rudder installation is obtained. In the 90 degree rudder position, the rudder forces cease, so that the steersman is completely released from effort, and can release very high port and starboard transverse thrust with a few turns of the wheel, without having to pass from hard port to hard starboard. The fins are advantageously flush in cross-sectional shape, i.e. they are in alignment with each other. Therefore, one or the other fin of the main rudder can lie optionally straight to the screw or vice versa. Thereby steering-times from either hard-over position can be shortened by almost half. In emergencies, especially in downstream river navigation, very high stopping-power can be gained by turning the rudder to 90 degrees and reversing the engine. When the vessel has been stopped in this way, the engine can be put into forward gear again, with the same rudder position, thereby allowing reverse thrust and steering-impulse to port and starboard with the screw rotating in the same direction. The vessel can thus be hove to very quickly. Again, turning on the spot can be done in an extremely short time, because of great transverse thrust taking effect at a main rudder position of about 30–40 degrees. Radial deflection is possible also on rotation of the rudder king-pin through 90 degrees, allowing reverse travel without reversing the engine, the screw still turning the same way as in forward travel. This is particularly important for ships equipped with a ship reversing gear, as the screw can be used in the emergency gear only for forward travel.

The so-called heaving-to of the ship is particularly important in downstream navigation, especially in pushers and pushed groups made up of barge and motor ship. Extremely short steering-times for the transverse thrust from port to starboard and vice versa can be obtained, as full rotation of the rudder from hard port to hard starboard becomes unnecessary. Again, rotation simultaneous with reverse travel can be obtained. Steering and reversing with an exchanged tunnel in the 90 degree position of the rudder is particularly desirable in an unballasted voyage, especially at low water. This feature of the rudder is particularly important for entry into canal locks, as it can occur that an engine in reverse can jump into forward gear, lock-gates etc. being damaged as a result. In an emergency, especially in going downstream, high stopping-power results in the 90 degree position, the said power supplementing the normal reversing power of the screw. Even at slow starting reverse speeds, the screw loses none of its efficiency. Again, right-angled turning of cuboid floating bodies can be easily and simply carried out, a factor important in port navigation.

Brief description of drawings

The invention is explained as follows with reference to the examples shown in the drawing:

FIG. 1 shows a simple, i.e., one-surface rudder installation according to the invention, in plan view, with different positions of the fin-rudder.

FIG. 2 is a twin rudder installation with the fin-rudder according to the invention shown diagrammatically in plan view, in various positions.

FIG. 3 shows a sketch partly in section of the steering-rod for the fin-rudder as used in FIG. 2, along line III—III of FIG. 4.

FIG. 4 is a plan view of the steering-rod along line IV—IV of FIG. 3, in a twin-rudder installation.

Description of specific embodiments

The rudder generally designated **1** is mounted relatively close to screw **10**. The rudder **1** includes three parts comprising a main rudder **4**, a rear fin **5** and a forward fin **3**. The fins **3** and **5** are connected to the main rudder **4** by means of piano like hinges **6**. A rudder stem **2** is used to rotate the main rudder **4**. The stem **2** is located either centrally or eccentrically on the main rudder **4** along its longitudinal axis. Guide rods **7** and **8** are fixedly attached to the upper side of fins **3** and **5** respectively at the axes of the hinges **6**. Both guide rods **7** and **8** extend in opposite directions with respect to each other. A rod **9** running diagonally to the main axis of the main rudder **4** joins the guide rods **7** and **8** at pivoting connections **7a** and **8a** respectively. As the guides **7** and **8** move during the rotation of the main rudder **4**, the angles formed between the fins **3** and **5** with respect to the main rudder **4** are thereby influenced. The steering arm **11** fixedly mounted on the stern at point **12** can engage at the other end thereof either one of the guide rods **7** or **8**. As the main rudder **4** turns around stem **2**, the fins **3** and **5** are pivoted to the same side of the main rudder **4** and in the direction of the screw **10**. In this way, a deeply curved surface is formed which very effectively deflects the current.

The pitch angle is that angle measured between the longitudinal axis of the particular fin or rudder portion from the longitudinal axis of the ship. The particular pitch angle for any one portion of the ship's rudder is a function of the current speed. With the single surface rudder the rear fin pitch angle is from 90 to 110 degrees over the ship's longitudinal axis. The pitch angles shown in FIG. 1 include a forward fin **3** pitch angle alpha equal to about 30 degrees, a main rudder **4** pitch angle beta equal to about 60 degrees and a rear fin **5** pitch angle gamma equal to about 90 degrees. At these angles the water is conveyed at right angles to the ship's longitudinal axis. The highest efficiency, relative to transverse thrust performance, is attained at pitch angles of beta about 37 to 40 degrees, alpha about 20 degrees and gamma about 60 degrees. These pitch angles can be altered to obtain special effects.

Each fin can also have an independent steering-rod of its own, the steering-arm engaging on the guide of each fin being fixed on its own at the other end. Thus the guides of both fins can lie to the same side of the main rudder, while the fixed points are to be attached on both sides of the main rudder.

In the example in FIG. 2, a twin-rudder installation is shown. Here the activating-rod for fins **3** and **5** jointed to main rudder **4** has been altered so that, instead of the steering-arm **11** in the example in FIG. 1, a fixed disc **13** is mounted on the fixed bearing-position **12**, the rotary stem **2** of the main rudder **4** passing through the said disc. Fixed disc **13** lies eccentric to the stem **2**. Thus bearing-rings **14** and **15** are mounted above one another on the fixed plate **13**, the rings being guided and freely rotatable on disc **13**. Guide arms **16** and **17** are fixed and extend radially from the bearing rings **14** and **15** respectively. Guide rods **7** and **8** connect the free ends of guide arms **16** and **17** to fins **3** and **5** respectively. The guide rods in the other fin rudder are mounted in a corresponding, mirror image fashion. On rotation of the main rudder **4** by means of stem-shaft **2**, the hinge-axes **6** move in a corresponding circle around the centre of stem-shaft **2**. Thereby each of the rod-parts **17, 8** and **7, 16** are carried along with it. As bearing-rings **14** and **15** move eccentrically to stem-shaft **2** around fixed disc **13**, there is automatic control and pivoting of fins **3** and **5** to the same side of the main rudder, and in a direction of screw **10**. In this formation of the steering-rod each fin is separately linked. Deviating from the rod-drive, there result automatic pitch angles which are not proportional. The relatively large dimensions of the eccentrically fixed disc **13** and rings **14** or **15** rotating around it, allow high stability and durability. If there is any damage to the outer fin, the power is diverted through the guide-arm to the eccentric ring. As the ring is freely rotatably only the guide-arms or guide-bolts are exposed to risk of damage. Angles delta and epsilon between main rudder and any fin can be of varying sizes. In the example shown, angles delta equals about 121 degrees, beta equals about 90 degrees and epsilon equals about 127 degrees. In order to achieve greater radial reflection the angles can be altered, e.g., for angles delta and epsilon in a range of 150 to 120 degrees. By means of predetermined pitch angles it can also be brought about that the average water output between both rudders from the 90 degree position becomes extremely high. A relatively fast and maximum-sized rudder opening is achieved with small movement of the rudder-stems, a relatively high transverse thrust being thereby achieved.

The stem-shafts **2** of main rudder **4** are preferably located in the middle of the rudder's longitudinal axis. Transverse plates, i.e., end-plates to increase the reverse thrust in radial deflection, are advantageously attached to the main rudder and on both sides of the fins, above and below. Thus transverse plate **18** can be provided above, and transverse plate **19** below the main rudder **4**, the said plates being connected to the stem-shaft **2**. Each fin **3** and **5** has at the top a transverse plate **20** or **21** for itself, which is linked to the hinge-shaft **6**. Lower transverse plate **19** can also extend over the area of fins **3** and **5**. Further transverse plates can be attached, distributed over the height of the rudder or rudders, said plates being parallel with the end-plates. The transverse plates can be mounted horizontally, or deviating from the horizontal. It is useful to mount the longitudinal axes of main rudder **4** and fins **3, 5**, in the zero degrees position, slightly positioned backward, as shown by lines **22** and **23**. In this way a more silent, easier movement is obtained. Rod **9** with guides **7** and **8** can also be attached horizontally at any other position, moved downwards, the main rudder **4** being correspondingly formed, and rod **9** passing through the main rudder. To provide motive power for moving the fins, rod **11** must then be activated with the fixed point **12** on one side, and on the other side with an additional guide **7** or **8**.

The moving device for the rod can also be united with those of the rings which are eccentrically set, e.g., while one fin is positioned by an eccentrically-set ring, and the positioning of the other fin is led off from the former by a rod. In this way angles delta and epsilon can each be kept at the same size. In the 90 degree position of the main rudder to the ship's longitudinal axis, both fins adopt the same angle, preferably about 135 degrees. The greatest transverse thrust, dependent on the drive-mechanism, is achieved at a beta angle of about 36–50 degrees.

The entire rudder, consisting of main rudder and both fins, should, depending on their dimensions, be roughly square in surface seen from the front (FIG. 3), the height of the rudder between the end-plates corresponding at least to the screw diameter. The length of each fin advantageously comes to about half the length of the main rudder.

The rudder installation according to the invention is suitable not only for the stern but also for the bow. The additional fitting of a bow installation in inshore and deep-water ships is of great importance in loading and unloading manoeuvres, in foul weather especially when sailing light in wind, in threatened damage and in other emergencies. The rudders can have flake-shaped plating. The plates engaging with one another can be convex and concave, or convex-concave and concave-convex, and in certain circumstances can be covered with elastic material, e.g., rubber or plastic. The rudder installation according to the invention is also suitable for multi-surface installations, especially for multi-screw ships with rudder-stems lying on the same cross sectional line. The middle rudder can be mounted offset from this transverse line, turned towards or away from the screw. Apart from this, staggering of several rudders in order to achieve half circles is possible. The multi-fin rudder can also be mounted on barges. The rudder installation is not limited to use on ships, but is also suitable in aircraft construction, e.g., as a lateral tailplane.

While the rudder installation has been shown and described in detail, it is obvious that this invention is not to be considered as being limited to the exact form disclosed, and that changes in detail and construction may be made therein within the scope of what is claimed without departing from the spirit of this invention.

What is claimed is:

1. A rudder assembly for controlling transverse thrust performance of a ship comprising

(a) at least one rotatable main rudder portion having a forward end and a rear end,

(b) a steerable fin portion pivotally linked to each end of the main rudder portion,

(c) said fin portions having surfaces which are substantially in alignment when the longitudinal axis of the said fin portions are positioned in corresponding relationship to the longitudinal axis of the main rudder portion,

(d) mounting means to provide said rudder and fin portions behind a screw of a ship,

(e) said rudder assembly being rotatable in an amount effective to locate the longitudinal axis of at least one of the said portions at least up to an angle of about 90° with respect to a plane parallel to the longitudinal axis of the ship, and

(f) control means to cause said fin portions to turn to the same side of the main rudder portion and in the direction of a ship's screw on rotating the main rudder portion.

2. A ship's rudder as defined in claim 1 wherein the said main rudder portion has an eccentrically located rotary axis.

3. A ship's rudder as defined in claim 1 wherein there are two main rudder portions, each said rudder portion being located on opposite sides of the longitudinal axis of the ship's screw,

each said main rudder portion having steerable fin portions pivotally linked thereto,

each said rudder portion being rotatable in a mirror-image relationship with respect to each other.

4. A ship's rudder as defined in claim 3 wherein each said main rudder portion has a centrally located rotary axis, and

said main rudder portions are located in a spaced apart relationship with respect to each other at a distance equal to about the diameter of the ship's screw.

5. A ship's rudder as defined in claim 1 wherein said control means include a stationary disk eccentrically mounted on the rotary axis of said main rudder,

two ring members rotatably mounted on said stationary disk,

a guide arm mounted at one end thereof to each said ring member and extending radially therefrom,

means connecting the other end of said guide arms to the rotary axis of said fin portions.

6. A ship's rudder as defined in claim 1 wherein the height of the rudder assembly is substantially equal to the width of the rudder assembly and

the width of each fin portion is substantially equal to about one-half the width of the main rudder portion, said widths being measured in the longitudinal direction of the ship's axis.

7. A ship's rudder as defined in claim 1 wherein there is a single-surface rudder including a main rudder portion and fin portions being movable through varying pitch angles with respect to the ship's longitudinal axis,

the pitch angle α between the front fin portion and the longitudinal axis extends from about 30 to about 36°,

the pitch angle β between the main rudder portion and the longitudinal axis extends from about 60 to about 72° and the pitch angle γ between the rear fin portion and the longitudinal axis extends from about 90 to about 110°.

8. A ship's rudder as defined in claim 1 wherein there is a double rudder including a main rudder portion having two linked and steerable fin portions mounted on each side of the longitudinal axis of the ship's screw,

said main rudder portions being movable to a transverse position of substantially 90° to the longitudinal axis of the ship, the angles between each of the fin portions and the main rudder portions attached thereto are substantially equal to each other and about 135° when said rudder portion is in said transverse position.

9. A ship's rudder as defined in claim 8 wherein the said angles between each of the fin portions and the main rudder portions are variable within a range of about 120 to about 150°.

10. A ship's rudder as defined in claim 1 wherein said ship's rudder includes transverse plates mounted on said main rudder portion and fin portions,

said transverse plates mounted on said fin portions being offset with respect to the transverse plate mounted on said main rudder portion.

11. A ship's rudder as defined in claim 1 wherein said control means includes

a rod running diagonally to the longitudinal axis of the main rudder portion,

guide rods fixedly attached at one end thereof to the fin portions and pivotally attached at the other end thereof to the diagonally located rod, and

a steering arm fixed at one end and connected with a said guide rod at the other end.

12. A ship's rudder as defined in claim 1 wherein said control means includes

a rod running diagonally to the longitudinal axis of the main rudder portion,

guide rods fixedly attached at one end thereof to the fin portions and pivotally attached at the other end thereof to the diagonally running rod, and steering arms fixed at one end and connected with each of the said guide rods at the other end.

13. A ship's rudder as defined in claim **1** wherein said control means includes

a steering arm having a fixed axis,

a fixed disc having rotatable rings set thereof mounted on the fixed axis of said steering arm,

guide arms fixedly mounted to the said rotatable rings and radiating outwardly therefrom, and

guide rods fixedly attached at one end thereof to the fins and pivotally attached at the other end thereof to the said radiating guide arms.

14. A ship's rudder as defined in claim **1** wherein the fins are mounted at a slightly offset angle with respect to the longitudinal axis of the main rudder.

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