May 1, 1951 J. F. ALLAN 2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

Filed March 8, 1946 7 Sheets-Sheet 1

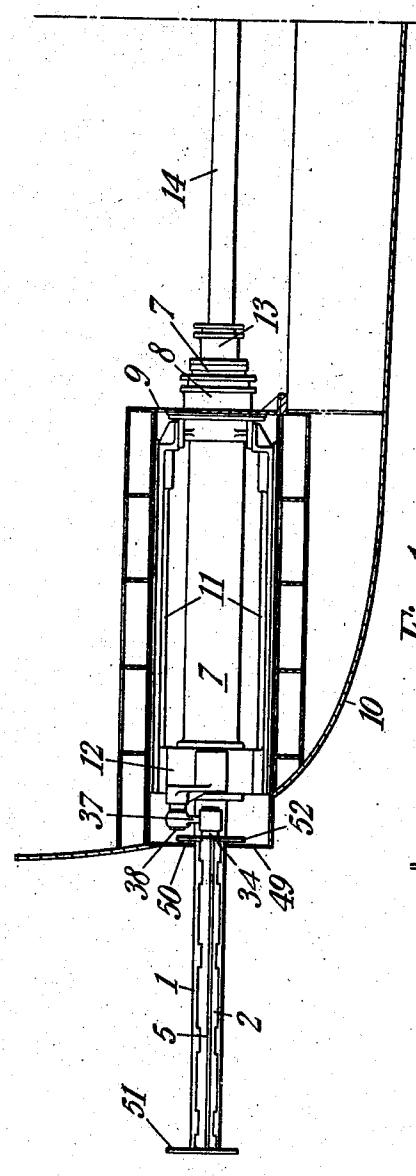

Fig. 1

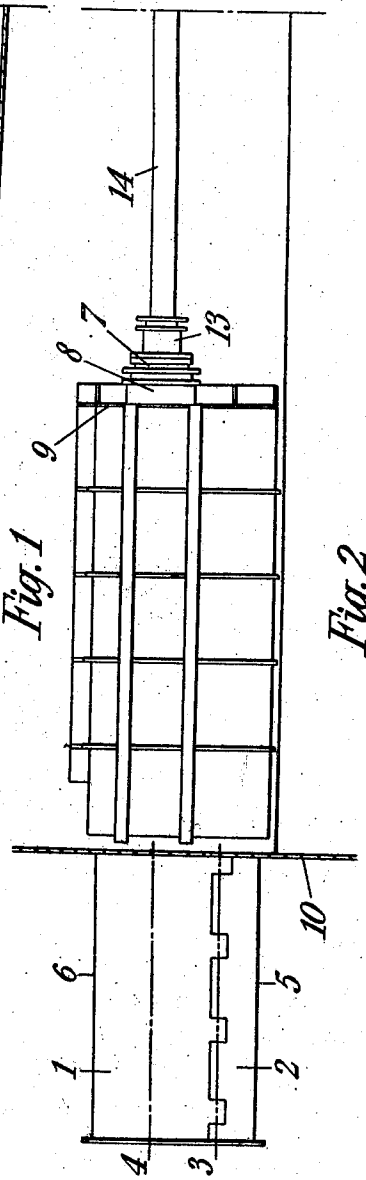

Fig. 2

Inventor
J. F. Allan
By Glascock Downing Seebold
Attys

May 1, 1951 J. F. ALLAN 2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

Filed March 8, 1946 7 Sheets-Sheet 2

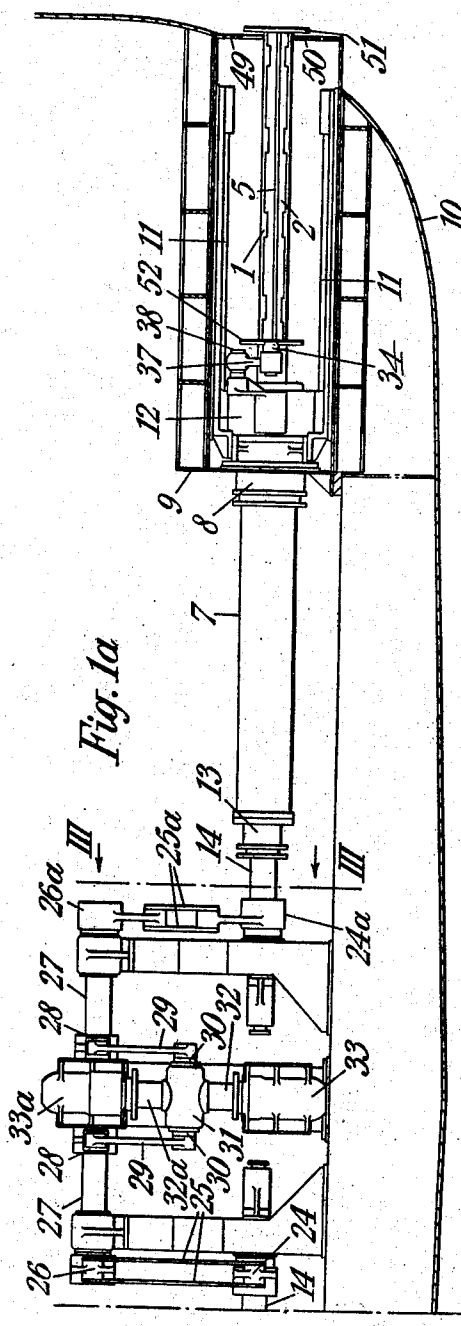

Fig. 1a

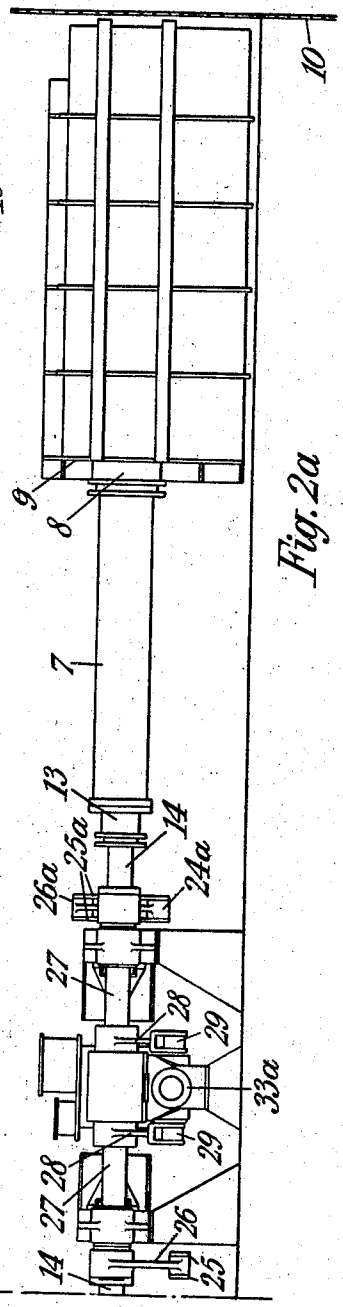

Fig. 2a

Inventor
J. F. Allan
By Glascock Downing Seibold
Attys.

May 1, 1951 J. F. ALLAN 2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

Filed March 8, 1946 7 Sheets-Sheet 3

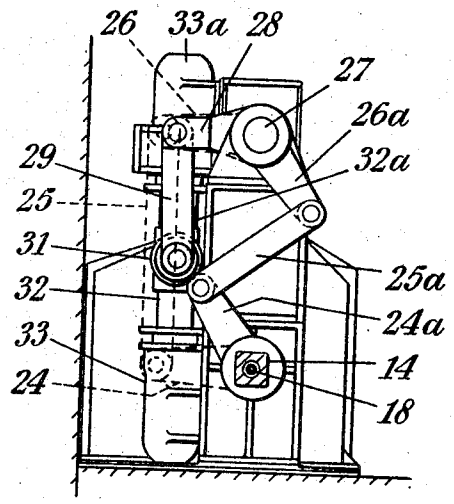

Fig. 3

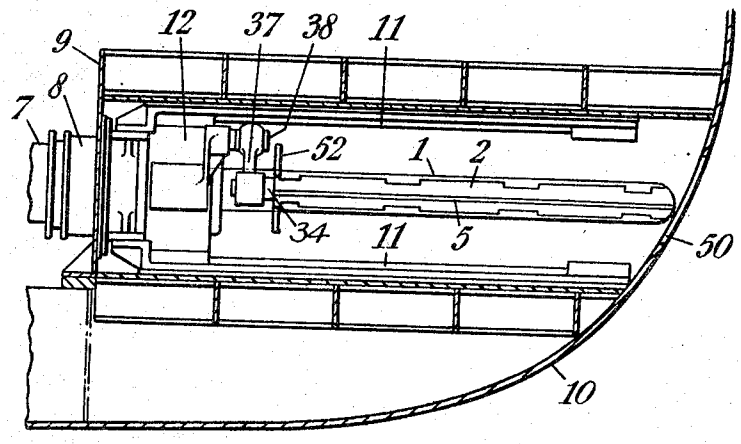

Fig. 6

Inventor
J. F. Allan
By Glascock Downing & Seibold
Attys.

May 1, 1951 J. F. ALLAN 2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

Filed March 8, 1946 7 Sheets-Sheet 4

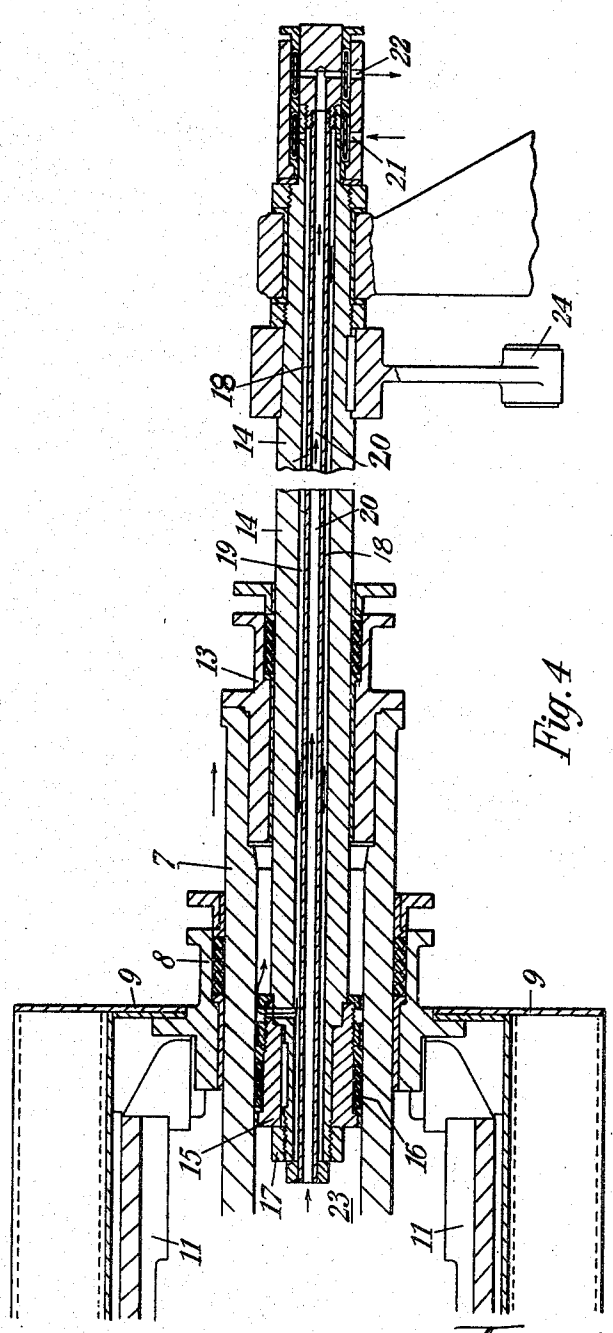

Fig. 4

Inventor
J. F. Allan
By Glascock Downing Seibold
Attys

May 1, 1951 J. F. ALLAN 2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

Filed March 8, 1946 7 Sheets-Sheet 5

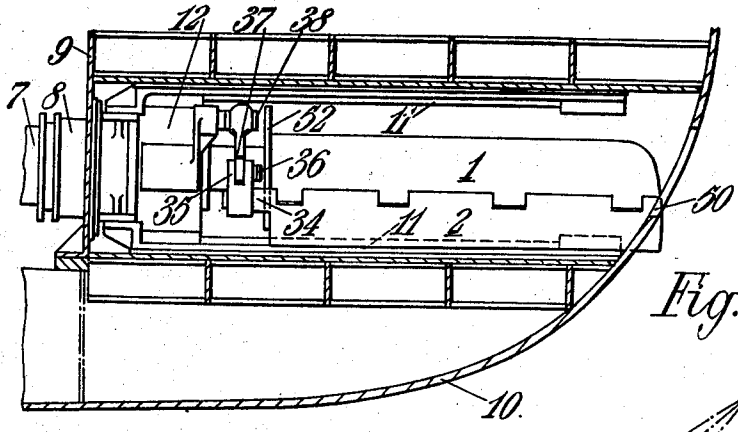

Fig. 5.

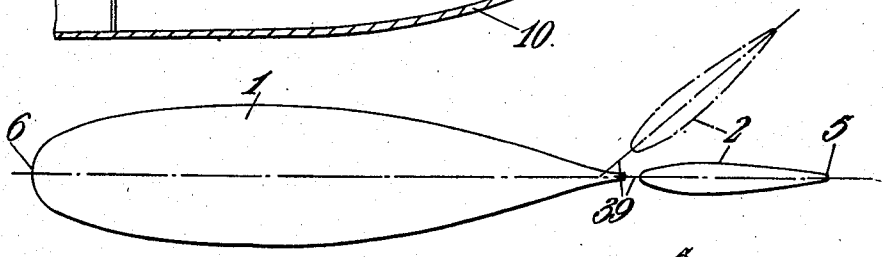

Fig. 7.

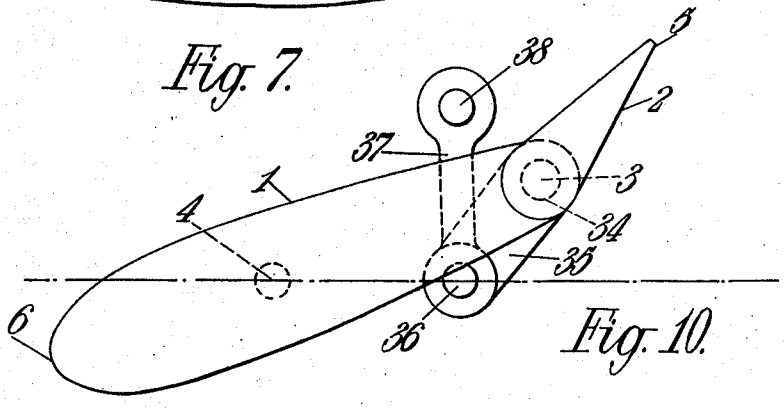

Fig. 10.

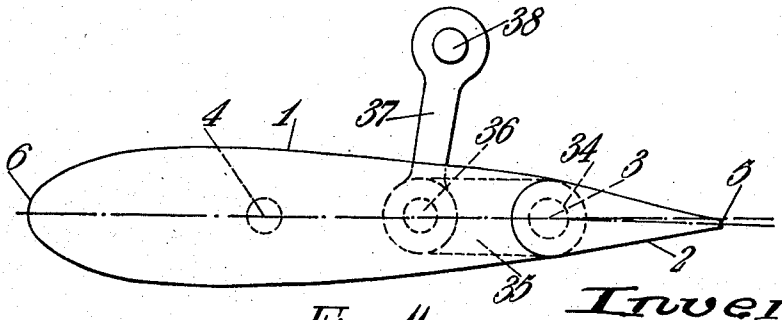

Fig. 11.

Inventor
J. F. Allan
By Glascock Downing Seibold
Attys.

May 1, 1951 J. F. ALLAN 2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

Filed March 8, 1946 7 Sheets-Sheet 6

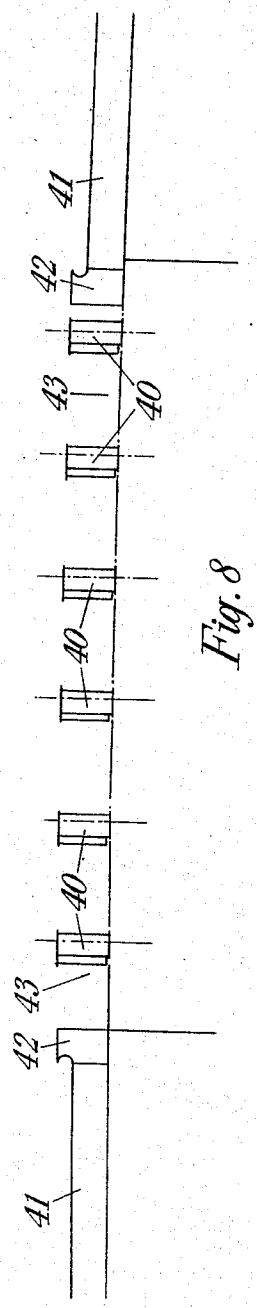

Fig. 8

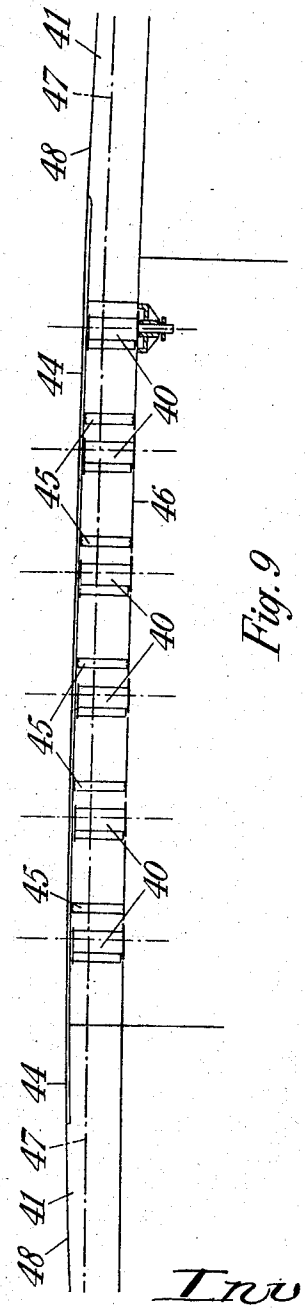

Fig. 9

Inventor
J. F. Allan
By Glascock Downing Seibold
Attys

May 1, 1951 J. F. ALLAN 2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

Filed March 8, 1946 7 Sheets-Sheet 7

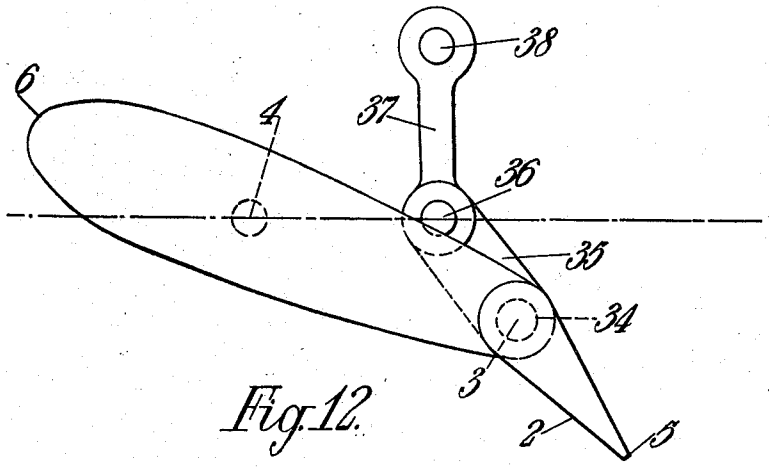

Fig. 12.

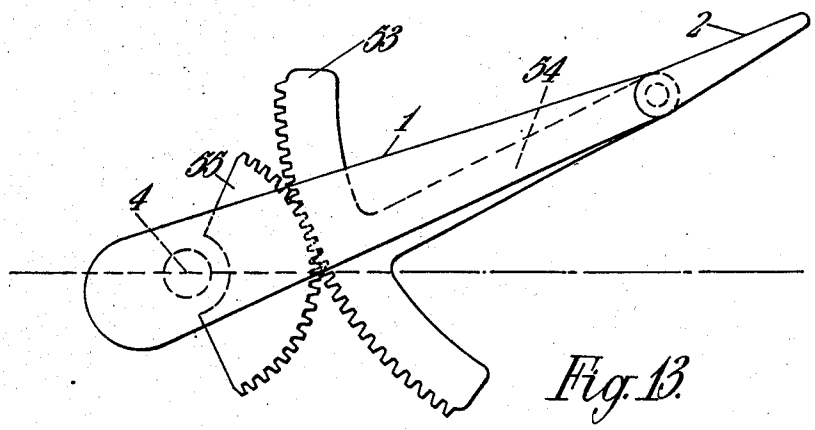

Fig. 13.

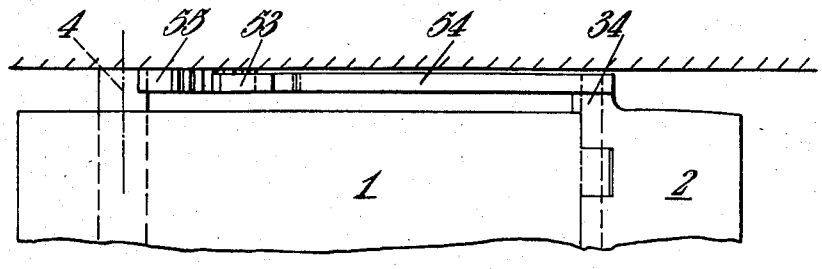

Fig. 14.

Inventor
J. F. Allan
By Glascock Downing & Seibold
Attys.

Patented May 1, 1951

2,550,752

UNITED STATES PATENT OFFICE

2,550,752

ROLL-STABILIZING OSCILLATING FIN INSTALLATION ON SHIPS

James Foggo Allan, Dumbarton, Scotland, assignor to William Denny and Brothers Limited, Dumbarton, Scotland, and Brown Brothers and Company, Limited, Edinburgh, Scotland

Application March 8, 1946, Serial No. 652,966
In Great Britain March 20, 1945

14 Claims. (Cl. 114—126)

1

The present invention relates to anti-rolling apparatus or roll stabilizers for ships. More particularly the invention relates to the type of apparatus including lateral fins arranged at or about the turn of the bilge of the ship and in which mechanism is provided for imparting tilting movement to the fins about axes disposed athwartship to produce anti-rolling couples on a travelling ship.

In known constructions of this type the total area of the fin surface required is large, irrespective of whether this area is provided by one fin or by a plurality of fins on each side of the ship and therefore the fins protrude a considerable distance beyond the lines of the hull and in the event the fins are retractable a large amount of internal space is required for housing the same when they are not in use. In some constructions it is necessary to provide a large number of non-retractable fins if the out-reach is not to exceed the maximum considered acceptable as a permanent protrusion in the vicinity of the bilge of the ship. It is believed obvious that the larger the fin area the greater the amount of power that will be required to tilt the same and therefore likewise the greater moment of inertia that has to be overcome before the fin has tilted with the resulting disadvantage that the response of the fin to the controlling mechanism is rather slow thereby minimizing the efficiency.

It is therefore an object of the present invention to provide an anti-rolling apparatus in which the stabilizing surfaces will provide for maximum efficiency with minimum fin area regardless of whether this fin area is provided by one or a plurality of fins on each side of the vessel or whether these fins are fixed or retractable within the hull line.

It is a further object of the present invention to provide in an anti-rolling apparatus a fin arrangement in which each fin includes a main and auxiliary fin in hinged connection with each other along a line parallel with the main axis about which the fin may be tilted as a whole and in which means are provided for tilting the auxiliary fin relative to the main fin in the same direction as but of greater amplitude of movement than the tilting movement of the main fin thereby providing an arrangement in which the auxiliary

2

fin augments the action of the main fin to increase the efficiency of the fin as a whole.

An additional object is to provide in an arrangement in which the fins are retractable within the hull and means for extending and retracting the fins to provide for ease of operation of the fin including a two part shaft, one carrying the fin and mounted for axial movement relative to the other and the other part being in splined connection with the axially movable part and capable of oscillation to impart tilting movements to the fin as a whole.

A further object is to provide mechanical means operatively connected to the auxiliary fin and responsive to the tilting movement of the main fin to impart tilting movement to the auxiliary fin relative to the main fin while the main fin is being tilted.

It is an additional object to provide in anti-rolling apparatus an overall increased efficiency for ships with bilge keels by disposing the stabilizing fins in such manner that they are generally co-planar with the planes of the bilge keels.

Further and more specific objects will be apparent when taken in connection with the following description with reference to the accompanying drawings in which:

Figures 1 and 1*a* are views in cross-sectional elevation of respectively the port and starboard halves of the hull of a ship in which the invention is provided;

Figures 2 and 2*a* are corresponding plan views;

Figure 3 is a view in section on a plane indicated by the line III—III of Figure 1*a*;

Figure 4 is a fragmentary view in sectional elevation showing on a larger scale certain details of construction;

Figure 5 is a side elevation of a retracted fin unit tilted downwards to show details of one form of a mechanical linkage arrangement for tilting the auxiliary fin;

Figure 6 is a view similar to Figure 5 with the fin unit in the neutral position;

Figure 7 is a diagrammatic representation of an alternative construction of fin unit;

Figures 8 and 9 being fragmentary plan views showing two alternative manners of applying the invention to the hull of a ship;

Figures 10, 11 and 12 are diagrammatic repre-

sentations of a fin unit in end elevation showing various relative positions assumed by the main and auxiliary fins and the parts of a linkage mechanism for tilting the auxiliary fin;

Figures 13 and 14 are diagrammatic representations of a non-retractable fin unit employing a toothed sector linkage for tilting the auxiliary fin, Figure 13 being a view in end elevation and Figure 14 being a plan view.

In the drawings the stabilizing fin comprises a main or forward fin part 1 and an auxiliary or rearward fin part 2. The parts are hingedly connected to each other along an axis indicated by the reference numeral 3 which is shown as parallel with the axis 4 constituting the main axis about which the fin as a whole is tilted. As shown the axis 3 about which the two fin parts are hinged to one another is disposed at a position in the vicinity of the aft edge of the main fin part 1 and at a position between 0.20 and 0.30 of the total distance between the leading edge of the main fin 1 and the aft or trailing edge of the auxiliary fin 2 and which disposition of the axis 3 results in the auxiliary fin 2 having fore and aft dimensions of from ¼ to ⅜ of the corresponding dimensions of the main fin. It is further noted that the axis 4 about which the fin as a whole may be tilted is centered a suitable distance for balance behind the leading edge 6 of the fin part 1 at a position between 0.30 and 0.35 of the total combined fore and aft dimensions of the main and auxiliary fins, or in other words between the edges 5 and 6.

For tilting the fin as a whole about its axis it is mounted on axially movable tubular main shaft 7, see particularly Figure 4, extending through a gland 8 provided in the inner end of a housing 9 secured to the shell plating 10. In the housing there are provided guide rails 11 for a cross-head 12 providing a bearing for the outer end of the tubular shaft.

Into the shaft and through an internally square sectioned gland 13 extends a square sectioned oscillatory shaft 14 which is also tubular, and on the end of this shaft there is provided a piston 15 with which is associated packing 16, the piston being secured on the shaft by a nut 17.

The piston is circular in section and within the bore of the shaft 14 there is located a tube 18 leaving a space 19 between its external surface and the inner surface of the squared shaft, the tube itself providing a further passage 20.

These passages are in communication with ports 21, 22 respectively connected through a reversing valve or system of valves with a pump by which fluid under pressure may be admitted to one or other side of the piston, fluid on the opposite side of the piston being allowed to escape.

According into which end of the chamber 23 provided in the shaft 7 fluid under pressure is introduced, the fin will in the constructions illustrated in Figures 1 to 6, be extended or retracted.

For rotating the fin as a whole about the axis 4 to the squared shaft there are secured arms 24, 24a.

One of these arms is connected by a link 25 with an arm 26 on a shaft 27, while the corresponding arm 24a is connected by a link 25a with an arm 26a on the other end of the shaft 27.

The position of these arms and their related link is shown more clearly in Figure 3 and this arrangement of the linkage between the arms on the shaft is necessitated by the fact that when the fin on one side of the vessel is tilted upward or downward, the fin on the other side of the vessel must be tilted downward or upward.

For imparting such motion to the shaft 27 which is connected by two arms 28 through links 29 with the ends 30 of a cross-head 31 secured to rams 32, 32a operating in cylinders 33, 33a, so that to whichever of these cylinders fluid under pressure is admitted, fluid being allowed to exhaust from the other cylinder, the crosshead will be moved upward or downward and thereby impart motion of the character in question to the fins as a whole.

For controlling the admission of fluid to these cylinders there is provided a mechanism generally of the character employed in known constructions in which fins or horizontal rudders are provided on ships and, for example, a mechanism as embodied in prior Patent 2,099,380, which is owned by the assignee of the instant invention.

When the main fin part 1 is rotated about the axis 4 this movement will impart motion to the auxiliary fin part 2 relative to the main fin in the following manner, as illustrated more particularly in Figures 5 and 10 to 12.

As illustrated the hinge pin 34 is rigidly connected with the arm 35 serving as a tiller for the auxiliary fin 2. This arm constitutes one element of the mechanical means that effects the movement of the auxiliary fin relative to the main fin and by means of a pin 36 the outer end of the arm 35 is connected with one end of a link or movable part 37, the other end of which is pivoted on a fixed pin or pivot 38 mounted on the cross head 12. It is noted, therefore, that as the fins are extended the pin 38 constitutes an element of the motion imparting means that is fixedly supported with relation to and movable with each fin upon extention. With the arrangement of the elements just described it will be seen that in rotating the main fin 1 about the axis 4 relative motion between the main fin and the auxiliary fin will be effected in one or the other direction depending on whether the main fin 1 is tilted in a clockwise or counter-clockwise direction. As illustrated when the main fin 1 is tilted upwardly from a neutral position the trailing edge of the auxiliary fin is likewise tilted upwardly as shown in Figure 10 but through a proportionately greater angle than the angle of tilt of the main fin. When the trailing edge of the main fin is tilted downwardly, as illustrated in Figure 12, the trailing edge of the auxiliary fin is tilted downwardly through a proportionately greater angle. In connection with the relative tilting motion as regards the main fin, the maximum angle of tilt provided for this fin will generally not exceel 20° from a neutral position and the tilting movement of the auxiliary fin can be such that it will be rotated about its axis or hinge connection with the main fin through an angle on the order of between 1¼ and 1½ times the angle through which the main fin is rotated and in the same direction of movement. In other words, the auxiliary fin will move through an angle of between 25° and 30° from the neutral position when the main fin is moved through an angle of 20° from the neutral position.

It is to be noted at this time that when the fin as a whole is in its neutral position or has zero tilt the auxiliary fin is inclined slightly downward toward its rearward edge as shown in Figure 11. This is because the construction of the elements 35, 36, 37 and 38 while of simple and robust character is asymmetrical and would normally give a slightly greater relative tilt in a

raised position than in a lowered position. The slight downward tilt at the intermediate, neutral position is of little or no consequence when the main fin is in the neutral position but corrects for the asymmetry of the arrangements in other positions. Nevertheless it is still apparent in the neutral positions that the main and auxiliary fins are in substantial alignment.

It is further to be mentioned at this point that when a retractable fin arrangement is adopted the required stabilizing forces can be obtained from a single fin of the above type on each side of the vessel and located near midship and as close to the bilge corner as possible.

In the construction shown in Figures 1 to 6 the trailing portion of the fin is shown hinged to the forward portion so that no gap is left between the two portions thereof. As disclosed the hinge line is in close proximity to the leading edge of the auxiliary fin and the trailing edge of the main fin, in which case in effect, the surfaces of the two fin portions provide substantially uninterrupted surfaces even when tilted relative to each other.

An alternative construction is illustrated in Figure 7 where the main or forward part **1** and the trailing portion **2** are hinged together along a line which lies forward of the rearward edge of the main fin so that when the auxiliary fin rotates relative to the main fin a slot or gap **39** will be formed between the leading edge of the auxiliary fin and the trailing edge of the main fin.

The construction described with reference to Figures 1 to 6 show retractable fins which are of relatively considerable span.

Within the scope of the invention, a plurality of fins of restricted span may be provided and these fins which are indicated by the reference **40** and are each constituted by forward and trailing sections are located on the line of the bilge keel **41** as shown in Figures 8 and 9.

In the construction shown in Figure 8 a guard **42** is provided on the adjacent ends of the bilge keels between which a space **43** is left for the accommodation of the fins.

In the case of the construction shown in Figure 9 the bilge keel is also interrupted but in this case a plate **44** is provided connecting the two portions of the bilge keel, and stiffeners **45** are provided between this plate and the skin **46** of the hull.

With such an arrangement it will be preferable to widen the bilge keel so that for instance assuming the chain-dotted line **47** represents the outer web of a keel such as would normally be provided, the outer edge of the keel actually employed in accordance with the invention is as indicated by the reference **48**.

In the construction shown in Figures 1, 1*a* and 2, 2*a*, the housings into which the fins may be retracted, as will be seen, extend beyond the general surface of the skin of the hull.

The outer wall **49**, in this construction, is provided with an aperture **50** of the form shown in Figure 5, and arranged to be partly closed when the fin is retracted by an end plate **51** secured to the outer end of the fin.

In certain of the figures there is also shown an inner end plate **52** which when the fin is extended will operate partly to close the aperture **50**.

In many cases it may be desirable to avoid any extension beyond the general surface of the hull in the vicinity of the fins and in this case the form of the hull will be generally as shown in Figures 5 and 6.

In the embodiment illustrated diagrammatically in Figures 13 and 14, the auxiliary fin **2** is rigid with hinge pin or shaft **34** and a link or arm **54** acting as a tiller, the other end of link **54** being connected to or integral with a toothed sector **53** meshing with a toothed sector **55**. The latter sector is concentric with axis **4**, namely, the axis about which the main fin **1** is tilted, but is secured from rotation, conveniently by fastening to the side of the ship. With such a construction, if R_1 be the radius of sector **55** and R_2 that of sector **53**, the proportion of the angle of tilt of the auxiliary fin to that of the main fin is clearly always

$$\frac{R_1+R_2}{R_2}$$

which, as indicated above, is preferably from 1.25:1 to 1.5:1.

It is to be noted that with regard to the foregoing description the particular arrangement of parts provides for maximum efficiency with minimum area of fin since the auxiliary fin augments the action of the main fin. The manner in which the auxiliary fin is moved relative to the main fin has been disclosed in connection with the particular embodiments of Figures 10 to 12 and Figures 13 to 14. However, it is pointed out that while the term link has been utilized with particular reference to the element **37** the invention is not to be limited other than by the scope of the appended claims. It is clear that both particular arrangements disclosed embody mechanical linkage means operatively connected with the auxiliary fin and responsive to the tilting movement of the main fin for tilting the auxiliary fin in the same direction as but through a greater amplitude of movement as regards the main fin. The term linkage as herein utilized is not to be limited in its meaning to denoting a system of links but is utilized in a broader sense as to denote and mean the act of linking or coupling the auxiliary fin for movement with the main fin. As indicated in Figure 13 the coupling effect is obtained by the meshing of the teeth on the respective sectors **53**, **55**. It is further to be noted that in connection with Figures 10 to 12 the arrangement provides three particular elements. The arm or element **35** which is movable relative to the main fin and rigid with the auxiliary fin, the fixed pivot pin **38** and the link **37** pivotally connected between the outer end of the arm **35** and the pivot **38**. In the arrangement of Figure 13 the arm **54** which is rigid with the shaft **34** consisting of the pivoting axis of the auxiliary fin **2** relative to the main fin **1** has embodied with it the sector **53** meshing with the fixed sector **55**.

It is further pointed out that in connection with this invention that fins as illustrated may be arranged either to be permanently extended beyond the line of the hull or be of the retractable type capable of being withdrawn within the hull within the housing provided therefore. In this latter instance the plate at the inner end of the main fin will be of a size suitable to include the fore and aft dimensions of the main and auxiliary fins and be operable within a suitable aperture in a shell plating. Further with this arrangement the plate may be provided at the outer end of the fins and function to close the aperture in a shell plating when the fins are retracted.

It is further noted that when a non-retract-

able fin arrangement is provided the required stabilizing forces may be obtained by a plurality of fin systems of the above described type on each side of the vessel. The out-reach of these fins may be commensurate with the depth of a large bilge keel and they may be fitted on the line of the bilge keel and preferably along the midship portion thereof, the bilge keel being interrupted over the length occupied by the fin units. Between each fin unit a fore and aft gap equal to at least four times the fore and aft dimensions of a fin unit, measured from the leading edge of the main fin to the trailing edge of the auxiliary fin, will be left clear, and a suitable gap will also be left between the end fin units and the adjacent bilge keel. A continuous outer bar may be fitted at the outer edge of the bilge keel enclosing and protecting the area of the fin units. Suitable support for this bar will be arranged over the fin area so as not to interfere with the flow of water to or from the fins. Alternatively, no protecting bar may be fitted but the bilge keel adjacent to the fins fore and aft may be suitably shaped and hardened so that it will cut any rope or other obstacle which is liable to foul the fins.

When multiple fin units are fitted the means of operation may be either individual or linked together in groups.

I claim:

1. Anti-rolling apparatus comprising lateral fins arranged substantially at the turn of the bilge, means mounting the fins for tilting movement about axes disposed athwartship, each of the fins including two parts in direct hinged connection one with the other along a line parallel with the main axis about which the fin may be tilted as a whole, said parts constituting leading and trailing sections and mechanical means for securing relative motion between the two parts of the fin including an element operably connected with said trailing section and responsive to the movement of said leading section for constraining the movement of said trailing section to pivotal movement of the said direction as but in greater amplitude than said leading section, said mechanical means further including at least one movable part connected to said element providing relative motion between the two sections of the fins dependent both in magnitude and direction upon the tilting motion imparted to the fin as a whole, said element being disposed in a plane perpendicular to said axes and constrained for movement in an arcuate path and thereby directly exerting force on said trailing section adjacent its axis of pivotation relative to said leading section so that when the fin is in a neutral position the respective median planes of the two sections will be in substantial alignment and when the fin as a whole is rotated to elevate its leading edge upward, the median plane of the trailing section will be inclined downward to a greater extent than is the median plane of the forward portion and conversely when the fin as a whole is tilted from its neutral position so that the leading edge of the leading section is lowered the median plane of the trailing section will be inclined upward to a greater extent than is the median plane of the leading section.

2. Roll stabilisers for ships comprising fin means extending laterally from opposite sides thereof substantially at the turn of the bilge, means for supporting and tilting the fin means including mechanism operable to apply respective opposite tilting movement to the fin means at the oppostie sides of the ship about main axes disposed athwartship to produce anti-rolling couples, each fin means including a leading section and a trailing section, each having leading and trailing edges, means pivotally interconnecting said sections along an axis spaced from and parallel with the main axis about which said fin means tilts as a whole, said means including a pivot journalled in the leading section adjacent the trailing edge thereof, said trailing section being rigidly connected to said pivot over a substantial portion of the length of the pivot, and means effecting relative motion between said sections including an element fixed with relation to said main axis about which the fin means tilt and mechanical force applying means operably connected between said pivot and said element and movable in response to the tilting movement of the fin as a whole to exert force on the trailing section to tilt the same in the same direction as the direction of movement of the leading section but of greater amplitude.

3. A roll stabiliser as defined in and by claim 2, and a rotatable shaft connected to said leading section for tilting the fin as a whole, a stationary toothed sector concentric with said shaft, a shaft providing the pivot about which said trailing section moves relative to said leading section, and a toothed sector carried by said last mentioned shaft and engageable with said first mentioned sector to effect pivotal movement of said trailing section relative to said leading section.

4. Anti-rolling apparatus for ships comprising fins on opposite sides of the ship, an axially movable shaft carrying each fin, an oscillatory shaft in splined relation with each axially movable shaft, at least one hydraulic motor for effecting oscillatory movements of said oscillatory shafts, hydraulic motors for effecting axial movements of said first mentioned shafts, said fins each including two sections pivotally interconnected, and means for imparting relative movement between said two sections and constraining the movement of the sections to tilting movement in the same direction, said means further imparting greater angular movement to one of said sections than the movement imparted to the other, and including a pivot shaft about which said sections pivot relatively to one another, a fixed pivot associated with each said axially movable shaft, and mechanical means interconnecting said fixed pivots with said first mentioned pivots and responsive to the oscillatory movement of said oscillatory shafts to impart said relative movement between said sections.

5. Roll stabilising apparatus for ships comprising retractable fins disposed substantially at the turn of the bilge of the ship and on opposite sides thereof, an axially movable shaft carrying each fin, said shaft being movable from an inboard retracted position to an extended position disposing the fins laterally of the ship, each fin comprising a trailing section and a leading section, a pivot shaft pivotally interconnecting said sections, an oscillatory shaft in splined relation with each said axially movable shaft, the oscillatory shafts for the fins on opposite sides of the ship being disposed in alignment with one another and terminating in spaced relation to each other within the ship, means for oscillating said shafts in respective opposite directions including a shaft supported parallel to said oscillatory shafts, double acting hydraulic motors oscillating said

last mentioned shaft, linkage respectively connecting the opposite ends of said last mentioned shaft with the respective inner ends of said oscillatory shafts, said linkage imparting respective reverse oscillations to said shafts whereby when the fin on one side of the vessel is tilted downwardly the fin on the opposite side of the vessel is tilted upwardly, hydraulic motors for extending and retracting each said axially movable shaft, and mechanical connections each including an element fixedly supported with relation to and movable with each said axially movable shaft and disposed adjacent the point of connection of each said shaft with each fin, an element fixed to each said pivot shaft connecting the fin sections together, and means movably connecting each said first and second mentioned elements whereby when each said oscillatory shaft oscillates the associated fin as a whole said last mentioned means exerts tilting force on each pivot shaft connecting said sections in the same direction as the direction of movement imparted by each said oscillatory shaft but of greater amplitude.

6. In an anti-rolling apparatus for ships of the type having at least one main lateral stabilizing fin including an aft edge, in the vicinity of the turn of the bilge and mechanism for tilting the fin with respect to a neutral position about a normally horizontal axis disposed athwartship, the combination thereof with an auxiliary fin that is relatively small with respect to the main fin, hinge means articulating said auxiliary fin to said main fin for pivoting movement about an axis parallel with said first mentioned axis and disposed in the vicinity of the aft edge of the main fin and mechanical linkage means operatively connected with said auxiliary fin and responsive to tilting movement of said main fin for tilting said auxiliary fin in the same direction as and through a greater amplitude of movement as regards the main fin.

7. In an anti-rolling apparatus for ships of the type having at least one main lateral stabilizing fin including an aft edge, in the vicinity of the turn of the bilge and mechanism for tilting the fin with respect to a neutral position about a normally horizontal axis disposed athwartship, the combination thereof with an auxiliary fin that is relatively small with respect to the main fin, hinge means articulating said auxiliary fin to said main fin for pivoting movement about an axis parallel with said first mentioned axis and disposed in the vicinity of the aft edge of the main fin and mechanical linkage means operatively connected with said auxiliary fin including a movable arm movable relative to the main fin responsive to tilting movement of said main fin for tilting said auxiliary fin in the same direction as and through a greater amplitude of movement as regards the main fin.

8. An anti-rolling apparatus for ships comprising lateral fins arranged substantially at the turn of the bilge, means mounting the fins for tilting movement about axes disposed athwartship, each of the fins including two parts in direct hinged connection one with the other along an axis parallel with the main axis about which the fin is tilted as a whole, said parts constituting leading and trailing sections, and mechanical means for effecting relative motion between the two parts including a movable arm operatively connected with said trailing section and responsive to the movement of said leading section about said first axis for constraining the movement of said trailing section to pivotal movement about said second axis in the same direction as but of greater amplitude than the movement of said leading section.

9. An anti-rolling apparatus for ships comprising lateral fins arranged substantially at the turn of the bilge, means mounting the fins for tilting movement about axes disposed athwartship, each of the fins including two parts in direct hinged connection one with the other along an axis parallel with the main axis about which the fin is tilted as a whole, said parts constituting leading and trailing sections, and mechanical means for effecting relative motion between the two parts including an element fixed with relation to said first mentioned axis, an arm operatively connected with said trailing section and means movably connecting the element with the arm so that the arm moves as said leading section tilts, thereby imparting tilting movement to said trailing section about said second axis, said movement being constrained to tilting movement in the same direction as but of greater amplitude than the movement of the leading section.

10. In an anti-rolling apparatus as defined in and by claim 6 wherein the hinge means connecting the main and auxiliary fins extends along a line disposed between .20 and .30 of the distance between the fore and aft dimensions of both fins whereby the auxiliary fin has fore and aft dimensions of ¼ to ⅜ of the dimensions of said main fin.

11. An anti-rolling apparatus as defined in and by claim 6, in which the main fin has a leading edge, the said normally horizontal axis about which the main fin tilts being disposed rearwardly of said leading edge at a position between .30 and .35 of the total fore and aft dimensions of the main and auxiliary fins.

12. Roll stabilizers as defined in and by claim 2 and including bilge keels extending from opposite sides of the ship and said fin means being generally co-planar with the planes of bilge keels.

13. An anti-rolling apparatus as defined in and by claim 6, wherein a rotatable shaft is connected to said main fin for tilting the same, a stationary toothed sector concentric with said shaft, said hinge means including a shaft providing a pivot about which said auxiliary fin moves relative to said main fin and a toothed sector carried by said last mentioned shaft and engageable with said first mentioned sector to effect pivotal movement of said auxiliary fin relative to said main fin.

14. An anti-rolling apparatus for ships comprising at least one lateral fin arranged substantially at the turn of the bilge and on opposite sides of the ship, means mounting the fins for tilting movement about axes disposed athwartship, mechanism for tilting said fins, each of the fins including two parts in direct hinge connection one with the other along an axis parallel with each of the first mentioned axes, said parts constituting leading and trailing sections and mechanical means for effecting relative motion between the two parts of each fin including a fixed pivot disposed parallel with said axes, an arm rigidly connected with said trailing section and a link pivotally connected at its opposite ends with said pivot and said arm respectively, said link and arm being disposed in planes perpendicular to all said axes and both said arm and said link being constrained for movement in an arcuate path for pivoting said trailing section about said second mentioned axis in the same

direction as but through a greater amplitude of movement than the tilting movement of said leading section.

JAMES FOGGO ALLAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
22,002	Yerkes	Nov. 2, 1858
1,800,365	Sperry	Apr. 14, 1931
2,040,984	Francesco et al.	May 19, 1936
2,099,380	Wallace	Nov. 16, 1937
2,198,295	Rosingh	Apr. 23, 1940
2,223,562	Giliberty	Dec. 3, 1940
2,369,832	Klose	Feb. 20, 1945
2,435,922	Davis	Feb. 10, 1948

FOREIGN PATENTS

Number	Country	Date
373,656	Great Britain	May 23, 1932
497,046	Germany	Aug. 24, 1927