Dec. 3, 1940. J. V. GILIBERTY 2,223,562

ANTIROLLING DEVICE FOR SHIPS

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FIG. 1

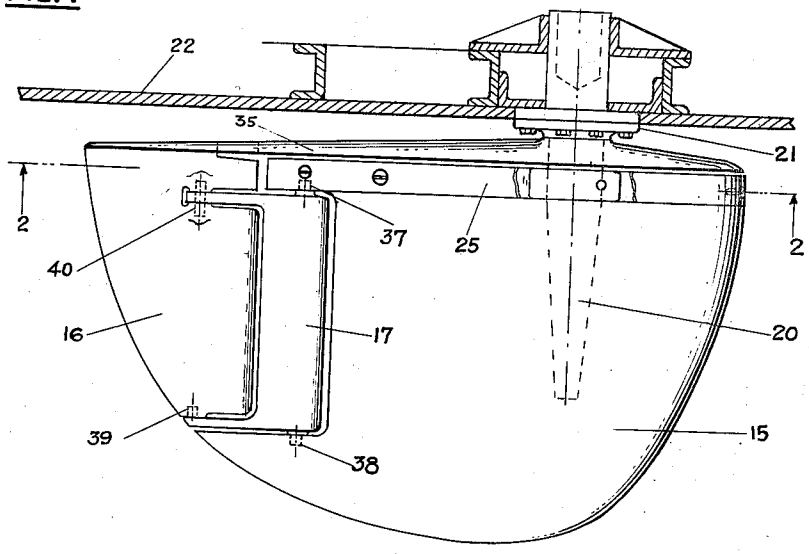
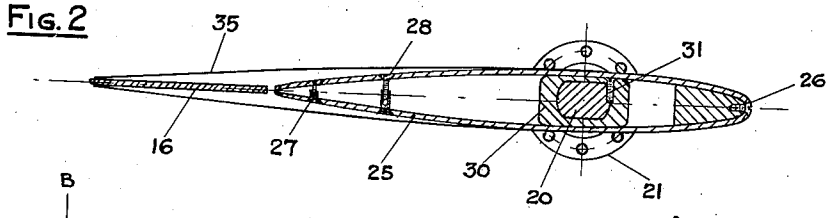


FIG. 2



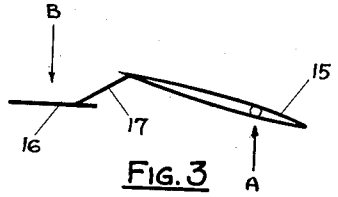


FIG. 3

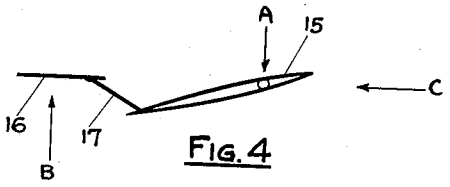


FIG. 4

FIG. 5

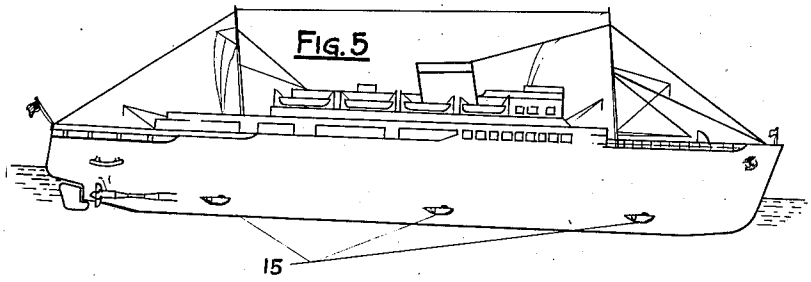


FIG. 6

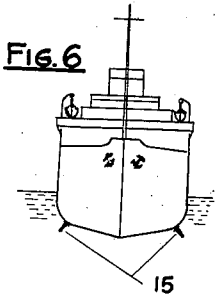


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FIG. 7

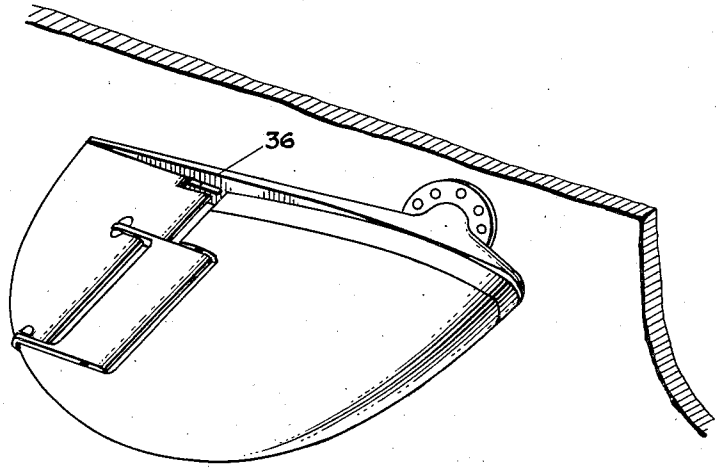

FIG. 8

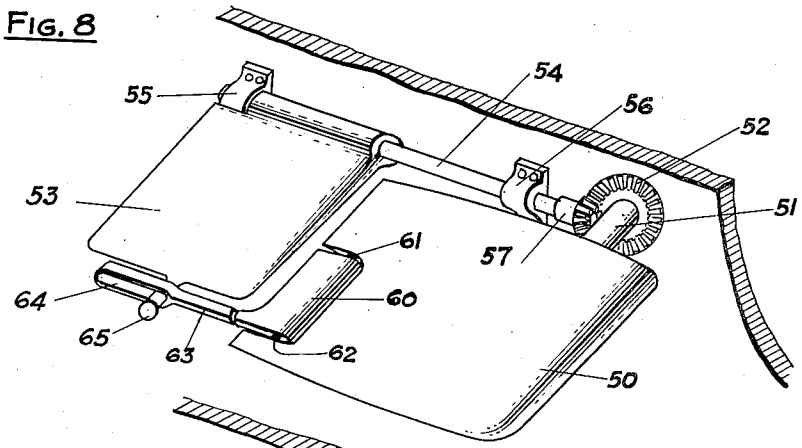

FIG. 9

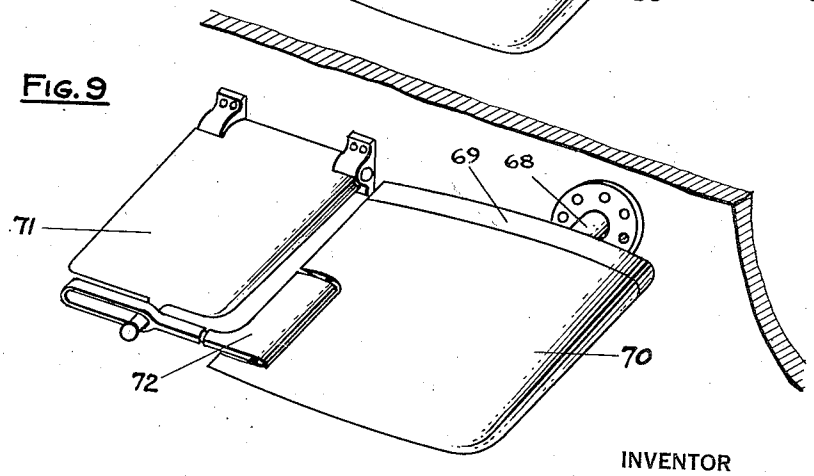

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FIG. 10

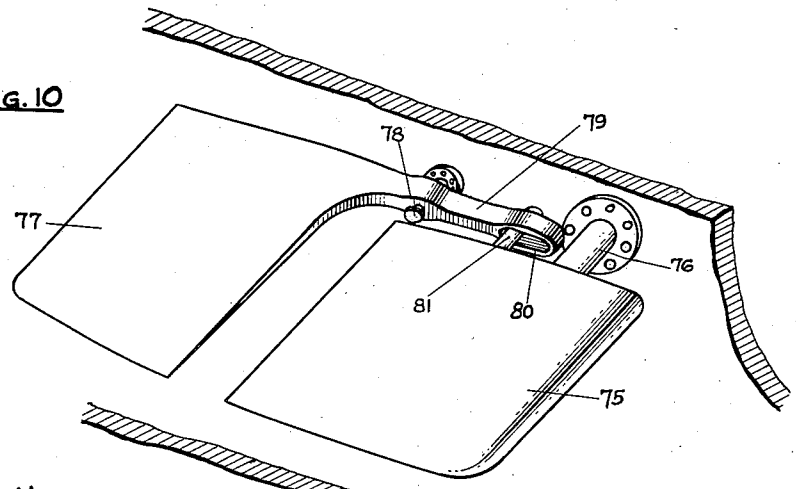


FIG. 11

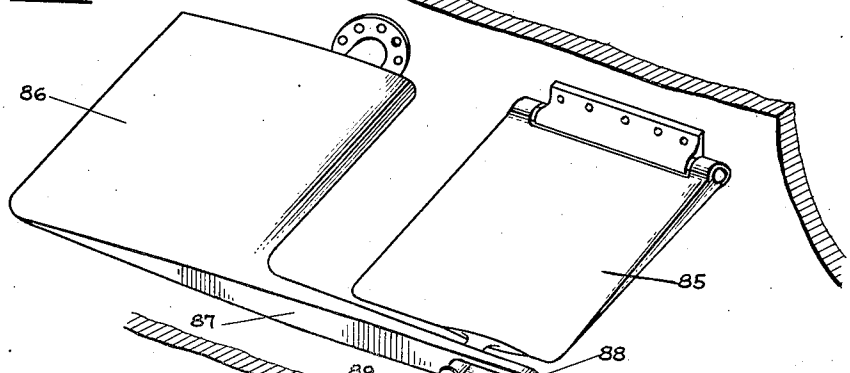
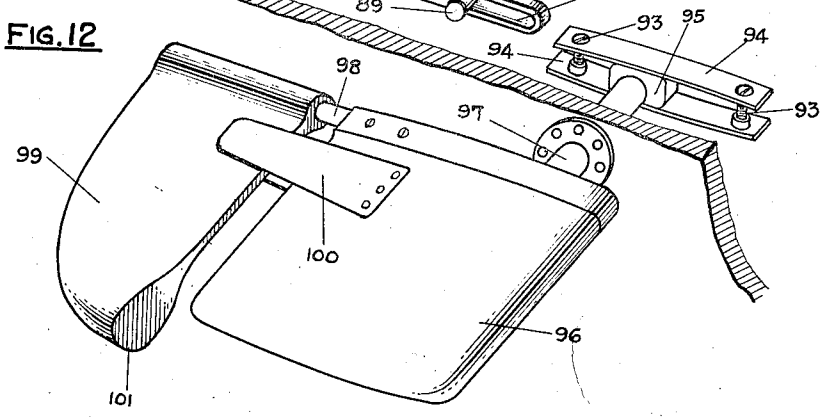


FIG. 12



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2,223,562

UNITED STATES PATENT OFFICE

2,223,562

ANTIROLLING DEVICE FOR SHIPS

James V. Giliberty, Hempstead, N. Y.

Application February 11, 1939, Serial No. 255,843

2 Claims. (Cl. 114—126)

This invention relates to antirolling devices for ships of the type in which stabilizing fins projecting laterally from the side of the ship are turned about an axis perpendicular to the longitudinal axis of the ship in such a direction as to oppose the rolling movements of the ship.

When such fins are located a substantial distance either forward or aft of the ship's center of gravity, they oppose the pitching movements of the ship as well as its rolling movements.

It has been proposed to change the angular positions of such fins by hydraulic or mechanical means located inside the ship and controlled by a gyroscope. While such means are very efficient, they are expensive to construct. They are also quite complicated and are therefore more susceptible to mechanical derangement.

The principal object of the present invention, therefore, is the provision of simple, inexpensive means for automatically changing the angle of attack of such fins in such a direction that the flow of water past the fins due to the ship's longitudinal movement through the water exerts pressure on the fins to oppose the rolling and/or pitching movements of the ship.

Where gyroscopic control is used the angular movement of the ship relatively to a horizontal plane is employed to change the position of the stabilizing fins. According to the present invention the angular movement of the ship relatively to the water is employed for that purpose, thereby greatly simplifying the construction and operation of the stabilizer.

Broadly speaking, the invention involves controlling the angular position of the fin by means of a plate, which will hereafter be called the control plate, mounted on the outside of the ship in such a way that it can move upwardly relatively to the adjacent part of the ship as such part moves downwardly through the water as the result of the upward pressure of the water on such plate.

On a large ship the lateral angular movement of its sides through the water due to rolling may be a considerable number of feet. The movement of the control plate relatively to the ship's side, may not be in excess of a few inches. As a result the total movement of the plate is downward, although there is a simultaneous movement of the plate upwardly with respect to the adjacent part of the ship's side. It follows, therefore, when reference is made to such plate moving upwardly, that it would be more accurate to say that it does not move downwardly as rapidly or as far as it would had it been rigidly secured to the ship's side. However, for convenience, movements of such plate and the other parts of the stabilizer will hereafter be referred to as upward or downward when such parts move upward or downward with respect to the adjacent side of the ship.

The control plate mentioned above is used to control the direction in which the fins are inclined with respect to the horizontal and also the magnitude of their angle of attack. It may control the angular position of the fins by controlling the application of motive power from the ship's power plant to the stabilizing fins. A simpler method is to connect each plate to an adjacent fin in such a way that the force exerted against the plate, resulting from the rolling and/or pitching of the ship, is transferred to the stabilizing fin in such a day that the angle of attack of the latter is changed in such a direction that the pressure of the water on the fin opposes the rolling and/or pitching movement of the ship. In either case, the rolling and/or pitching movement of the ship acting through the control plate controls the angle of attack of the fin both as to direction and also as to magnitude with respect to the fore and aft flow of water.

Where the stabilizing fin is turned as the result of a direct connection between the stabilizing fin and the control plate, the stabilizer units are self-contained and positive in action. This results in greatly simplifying the construction and operation of the stabilizer and thereby contributes to greater reliability.

Another simple, and the preferred, method is to use the control plate to throw into operation fin deflecting means which derive their deflecting force from the forward motion of the ship. It is advantageous to use the pressure created by the forward movement of the ship through the water to turn the stabilizing fin for the reason that, per unit of area, it is so much greater than the pressure due to rolling movement. For example, one large ship has a maximum circumferential rolling movement of around 1.8 feet per second. On the other hand, the same ship at full speed travels at 30 knots or more, which is equivalent to a speed of over 50 feet per second.

With either of the last two mentioned arrangements, the angle of attack of the stabilizing fins is controlled by the control plates independent of any motive power for said control other than the forces resulting from the ship's angular movement and the ship's forward velocity.

In the preferred mode of carrying my invention into effect, there are a series of stabilizing fins, each mounted on the outermost part of a ship's hull so that its axis of rotation is approximately perpendicular to the longitudinal axis about which the ship normally rolls. Desirably these fins are mounted in pairs symmetrically located on either side of the ship. Also mounted on the ship, close to the above mentioned fins, are the control plates. The latter may be arranged to oscillate in either or both of two ways relative to the stabilizing fin. First, about an axis parallel to, or coincident with, that of the stabilizing fin, or second, about an axis at right angles to the axis of rotation of the stabilizing fin and usually parallel to the longitudinal axis of the ship.

In all cases, the normal or neutral position of the control plate is such that its plane is parallel to the direction of fore or aft movement of the ship. If the control plate is mounted so as to turn about an axis which is also parallel to such direction of movement, its plane is always parallel to the fore and aft water flow. If, on the other hand, the control plate is arranged to turn about an axis parallel to, or coincident with, that of the stabilizing fin, its plane does not maintain this parallelism. The extent to which parallelism is departed from for any given lateral movement of the center of pressure of the control plate depends on how far such center of pressure is from the axis about which such plate swings.

Any angular velocity of roll produces a strong reaction on the control plate. This reaction is utilized to actuate the stabilizing fin, through gears, links, levers, or through the medium of a pilot rudder attached to the stabilizing fin. The connection provided between the stabilizing fin and the control plate is such that movement of the control plate causes the leading edge of the stabilizing fin to move in the same direction as the control plate, thereby producing a force on the hull tending to check the rolling motion of the ship.

As the stabilizing fin moves edgewise through the water as the result of the forward movement of the ship, the force required to turn the fin out of parallelism with the direction of movement of the ship depends on how well the fin is balanced. The nearer the turning axis is to the balance point the less the force required.

If the fin were perfectly balanced hydrodynamically, the force required to turn it would be only that required to overcome the friction of the fin support. In practice, perfect balance is impossible as the position of the turning axis of the fin to produce perfect balance varies with the speed of the ship; the higher the speed the nearer such axis would have to be to the leading edge of the fin. The important point is that two forces have to be overcome to cause the leading edge of the fin to incline upwardly as the fin as a whole moves downwardly, viz.: the force due to the rolling motion of the ship and that due to the turning movement required to give the fin a correct angle of attack. Both these forces are in the same direction and they are both reduced by mounting the fin on the balanced rudder principle. To prevent the fore and aft flow of water turning the fin broadside on or completely around through 180°, the fin should be mounted with its axis of rotation forward of the balance point of the fin at the maximum speed of the ship.

On the other hand, it is desirable that the control plate should be not only wholly unbalanced but also mounted so that, as it moves upwardly as the adjacent side of the ship moves downwardly, it does not move markedly out of parallelism with the fore and aft flow of water. Any marked angular movement of the control plate away from parallelism with the fore and aft flow means an unnecessary checking of the forward movement of the ship and usually also exerting a thrust laterally in opposition to that produced by the stabilizing fin when turned so as to oppose the rolling motion of the ship. A close approach to constant parallelism is obtained by mounting the control plate on the end of a long arm so that over a considerable range of vertical or lateral movements there is only a slight change in the angle of attack with respect to the fore and aft flow of water, or by mounting the control plate so that its axis of rotation is approximately parallel to the longitudinal axis of the ship.

A fin freely rotatably mounted on a shaft projecting laterally outwards from the hull with its axis of rotation forward of the balance point of the fin would be deflected by the rolling action of the ship in such a direction that such fin would accentuate the rolling, i. e. give it an angle of attack in the wrong direction. In order to prevent this, it becomes necessary by auxiliary means to apply forces which not only overcome the above mentioned inherent tendency to produce the wrong angle of attack, but also to produce a deflection of the fin in the opposite direction, so that the desired angle of attack in the right direction to resist roll is produced.

Various embodiments of my invention are illustrated, by way of example, in the accompanying drawings, wherein:

Fig. 1 is a plan view of the preferred form of my stabilizer;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a diagrammatic sectional view of the stabilizer of Fig. 1, showing the position of the parts as the stabilizer is pushed upwardly through the water by the rolling of the ship;

Fig. 4 is a view similar to Fig. 3 showing the position of the parts as the stabilizer is moved downwardly through the water by the return roll of the ship;

Fig. 5 is a side elevation of a ship equipped with my stabilizers in place of the usual bilge keels;

Fig. 6 is a front elevation of the same;

Fig. 7 is a perspective view of the form of stabilizer shown in Fig. 1; and

Figs. 8 to 12, inclusive, are perspective views of modified forms of my stabilizer.

In the preferred form of stabilizer shown in Figs. 1 to 7, inclusive, 15 represents the stabilizing fin, 16 the control plate, and 17 a pilot rudder pivotally connected to both the stabilizing fin and control plate.

The stabilizer as a whole is rotatably mounted on a stub shaft 20 having a flange 21 at one end by which it may be secured to the side 22 of the ship.

It is desirable to provide means for yieldingly holding the stabilizer more or less parallel to the direction of forward movement of the ship until such time as the ship begins to roll and/or pitch, and the stabilizer is thereupon brought into action. Various forms of springs may be used for this purpose. The preferred form of construction, as shown in Fig. 1, is a U-shaped leaf spring

25 the mid-portion of which is attached to the front end of the fin by a screw 26, while the ends of the spring are coupled together by tension adjusting screws 27 and 28. On the stub shaft 29 is mounted a cam 30 attached to a set-screw 31. This cam has flat sides against which the two halves of the spring press. As the fin turns either way from the position shown in Fig. 2, the two halves of the spring are forced apart.

The construction shown has the advantage that the fin can be turned 180°, so that it can operate as a stabilizer when the ship is going astern as well as when it is going forward.

Rotatably mounted on the shaft 20 between the flange 21 and the cam 30 is an arm 35, slotted at 36 (Fig. 7) at its rear end to slidably receive one edge of the control plate 16. The control plate 16 is coupled to the fin 15 by a pilot rudder 17. The latter is pivotally connected to the fin 15 by lugs 37, 38 and to the control plate 16 by a lug 39 and a pin 40.

When the ship rolls, the fin 15, control plate 16 and pilot rudder 17 assume the positions shown in Figs. 3 and 4 alternately. When the ship rolls in the direction of the arrow A (Fig. 3) so as to push the stabilizer as a whole upwards through the water, the control plate is pushed downwardly in the direction of the arrow B. As shown, this downward movement of the control plate has moved the rear edge of the pilot rudder downwardly into the path of movement of the water flowing longitudinally of the ship in the direction of the arrow C, due to its forward movement. The pressure on the pilot rudder so produced has restricted the downward movement of the control plate and at the same time pushed the rear part of the fin 15 upwardly. This last mentioned effect is the important one, as it is the one which results in the deflecting of the stabilizer fin in such a direction as to counteract the rolling movement of the ship. When the return roll takes place, the movements are all reversed, as indicated in Fig. 4.

It may be said that the control plate is floating, that is, it has complete freedom of movement in either direction from its central position. It follows then that a lateral movement of the fin unit which is equivalent to the movement of the ship in the direction of arrow A results in the movement of the control plate in the direction of arrow B. This relatively opposite movement is caused by the resistance offered by said plate to lateral movement through the water. Since the control plate is pivotally connected to the pilot rudder it follows that the movement of the control plate causes the pilot rudder to assume an angle of attack relative to the normal streamlines. Through the medium of the pivot connections 37 and 38 (Fig. 1) the resultant force on the pilot rudder due to forward ship velocity then acts to give the stabilizing fin proper, its correct angle of attack. This last mentioned effect is the important one, as it is the one which results in the deflecting of the stabilizer fin in such a direction as to counteract the rolling movement of the ship. It will be noted that the pilot rudder is balanced, i. e. the axis about which it turns is well aft of its leading edge. As a result it is readily turned by the control plate.

It will be noted that the magnitude of the angle of attack of the stabilizing fin proper is also automatically controlled. When a ship is in a calm sea there is no angular velocity and therefore the stabilizing fin, pilot rudder, and control plate assume their neutral or central position. A slight angular velocity resulting from a moderate sea will cause a slight movement of the control plate with a corresponding slight movement of the pilot rudder and stabilizing fin. A large angular velocity resulting from a heavy seaway will cause a corresponding greater movement of the control plate, with a consequent greater movement of the pilot rudder and stabilizing fin. It follows then that the corrective moment is automatically controlled, and its magnitude is proportional to the angular velocity.

It will be further noted that the action of the fins is such that they produce a force in a direction opposite to that in which the stabilizing unit as a whole is oscillating. Therefore, the location of said fins on a ship may be such that they can produce forces to oppose rolling and or pitching.

In a mixed sea where intermittent rolling and pitching exists, the stabilizing fins herein described automatically adjust themselves to those conditions. The fins respond immediately to any roll or pitch movement regardless of what sequence such roll or pitch may be or regardless of what combination of roll or pitch may exist.

It is possible to do without a pilot rudder, and Figs. 10, 11 and 12 show three forms of construction in which it is not used. Further, it is not essential that the control plate swing about an axis perpendicular to the ship's side. The control plate may be mounted so as to turn about a horizontal axis parallel to the ship's side, as shown in Figs. 8, 9, 11 and 12. These modifications are illustrated to show in what diverse ways the general principles of my invention may be carried into practice.

In the form shown in Fig. 8, the stabilizer fin 50 is mounted to turn about a shaft (not shown) projecting outwardly from the ship's side. Journaled on this shaft and rigidly secured to the fin 50 is a sleeve 51 carrying a bevel gear 52. The control plate 53 is rigidly mounted on a shaft 54, journaled in bearings 55 and 56 secured to the ship's side. Non-rotatably secured to the forward end of the shaft 54 is a bevel pinion 57 in mesh with the bevel gear 52. If the stabilizer is pushed downwardly through the water by the rolling of the ship, the control plate swings upwardly, turning the shaft 54 and thereby turning the fin 50 so that the water flowing longitudinally along the ship's side strikes the under side of the fin and produces an upward thrust on the stabilizer which counteracts the rolling movement. On the return roll the control plate swings downwardly and presents the top surface of the fin to the longitudinal flow of water. By reason of the fact that the control plate is wholly unbalanced and the stabilizer fin is largely balanced, a comparatively small upward force on the control plate will produce a very much greater upward force on the fin 50, and vice versa.

If desired, the turning of the stabilizing fin 50 may be aided, as shown, by a pilot rudder 60 pivotally mounted at 61 and 62 in a recess in the rear edge of the fin. This rudder has an arm 63, slotted at 64 for the reception of a pin 65 extending from the outer margin of the control plate 53. This pilot rudder 60, although somewhat smaller, acts in the same way as the pilot rudder 17 in the form of construction shown in Figs. 1, 2 and 7.

The form of stabilizer shown in Fig. 9 is simi-

lar to that of Fig. 8 except that the fin 70 is turned by the control plate 71 solely through the intermediary of the pilot rudder 72. In this case, therefore, the pilot rudder is a necessity, not merely an optional accessory, as in the form shown in Fig. 6. The stub shaft 68 and spring 69 in this stabilizer is similar to the corresponding parts of Fig. 1.

Figs. 8, 9 and 10 show various forms of stabilizer in which no pilot rudder is used. In Fig. 10 the stabilizer fin 75 is rotatably mounted on a shaft 76. The control plate 77 is rotatably mounted on a stub shaft 78, so that it swings about an axis parallel to but spaced apart from that about which the fin 75 turns. To cause the rear part of the fin 75 to move downwardly while the control plate moves upwardly and vice versa, the control plate is provided with a forwardly extending arm 79, slotted at 80 for the reception of a pin 81 projecting from the inner edge of the fin 75.

In Fig. 11 the control plate 85 is hingedly connected to the ship's side. The fin 86 has a forwardly extending arm 87 slotted at 88 to receive a pin 89 projecting from the outer edge of the plate 85.

The stabilizer of Fig. 12 comprises a fin 96 rotatably mounted on a shaft 97 and provided with leaf springs 94 which cooperates with a flat sided cam 95 in exactly the same manner as the spring 25 and cam 30 of the form shown in Figs. 1, 2 and 7. The difference in this case, however, being that said springs, cam and adjusting screws 93 are placed inside the hull, and secured thereto. Extending rearwardly from the inner part of the fin 96 is a shaft 98 on which a control plate 99 is pivotally mounted. Leaf springs 100 attached to the fin and extending rearwardly, one each side of the control plate, serve to yieldingly hold the latter in substantially the same plane as the fin, until rolling or pitching commences.

The forward edge of the plate 99 is enlarged at its outer end so as to provide a surface 101 having area sufficient to offer considerable resistance to the longitudinal flow of water along the ship's side. In the beginning of a downward roll, the control plate 99 is deflected upwardly while fin 96 is yieldingly held neutral by means of the springs 94. Having moved upwardly, the force due to forward ship motion acting on the surface of 101, causes the trailing edge of fin 96 to move downwardly, thus causing it to be in the correct position to oppose the rolling movement.

In the preferred form of stabilizer shown in Fig. 1, the cam 30 and leaf spring 25 is shown outside the hull. It is to be understood that the arrangement of the cam and spring inside the hull as shown in Fig. 12, can also be applied to Figs. 1, 7 and 9. This arrangement has the advantage in that it enables the fin to be set to its neutral position at any point along the hull. Thus, if a fin is placed at a point where the streamlines are out of parallelism with the longitudinal axis of the ship due to eddy currents or to the wave making effect of the ship's hull, adjustments of the fin to suit those conditions can easily be made. Having the cam and spring on the inside of the hull also has the advantage in that the spring tension can be adjusted while the ship is under way.

What is claimed is:

1. An antirolling device for water-borne ships comprising a stabilizing fin having leading and trailing edges pivotally attached to the side of the ship, the axis of said pivot being substantially perpendicular to the axis about which the ship rolls and also at a substantial angle to the vertical central plane of the ship, said fin being mounted on its pivot so that said pivot is a substantial distance ahead of the geometrical center of said fin and a substantial distance behind its trailing edge to produce a balanced rudder action, a control plate pivotally mounted on the side of the ship to turn about an axis fixed with respect to the ship, the axis of the pivot of said plate being outside the body of but in the same plane as said plate so that the latter is unbalanced, the last-mentioned axis also lying in the plane which includes the rolling axis of the ship and that part of the side of the ship to which the control plate is attached to permit the latter to be moved by the water with respect to the ship with rolling movements of the ship, and means interconnecting the control plate and fin for turning the stabilizing fin so constructed and arranged that the trailing edge of the fin moves about the axis of the fin in the same direction as that in which the adjacent side of the ship is moving as the result of such rolling movement.

2. An antirolling device for water-borne ships comprising a stabilizing fin having leading and trailing portions pivotally attached to the side of the ship, the axis of said pivot being substantially perpendicular to the axis about which the ship rolls and also at a substantial angle to the vertical central plane of the ship, said fin being mounted on its pivot so that said pivot is a substantial distance ahead of the geometrical center of said fin and a substantial distance behind its trailing edge to produce a balanced rudder action, a control plate located to the rear of said fin, said control plate having leading and trailing portions, a supporting arm connected to said plate and pivotally connected to the side of the ship at the same point as said fin but movable independently of the latter, a pilot rudder having leading and trailing portions, located between the leading portion of the control plate and the trailing portion of the fin and having its leading portion connected to the trailing portion of the fin and its trailing portion connected to the leading portion of the control plate whereby movement of the control plate resulting from lateral pressure of the water due to rolling moves both the pilot rudder and stabilizing fin.

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