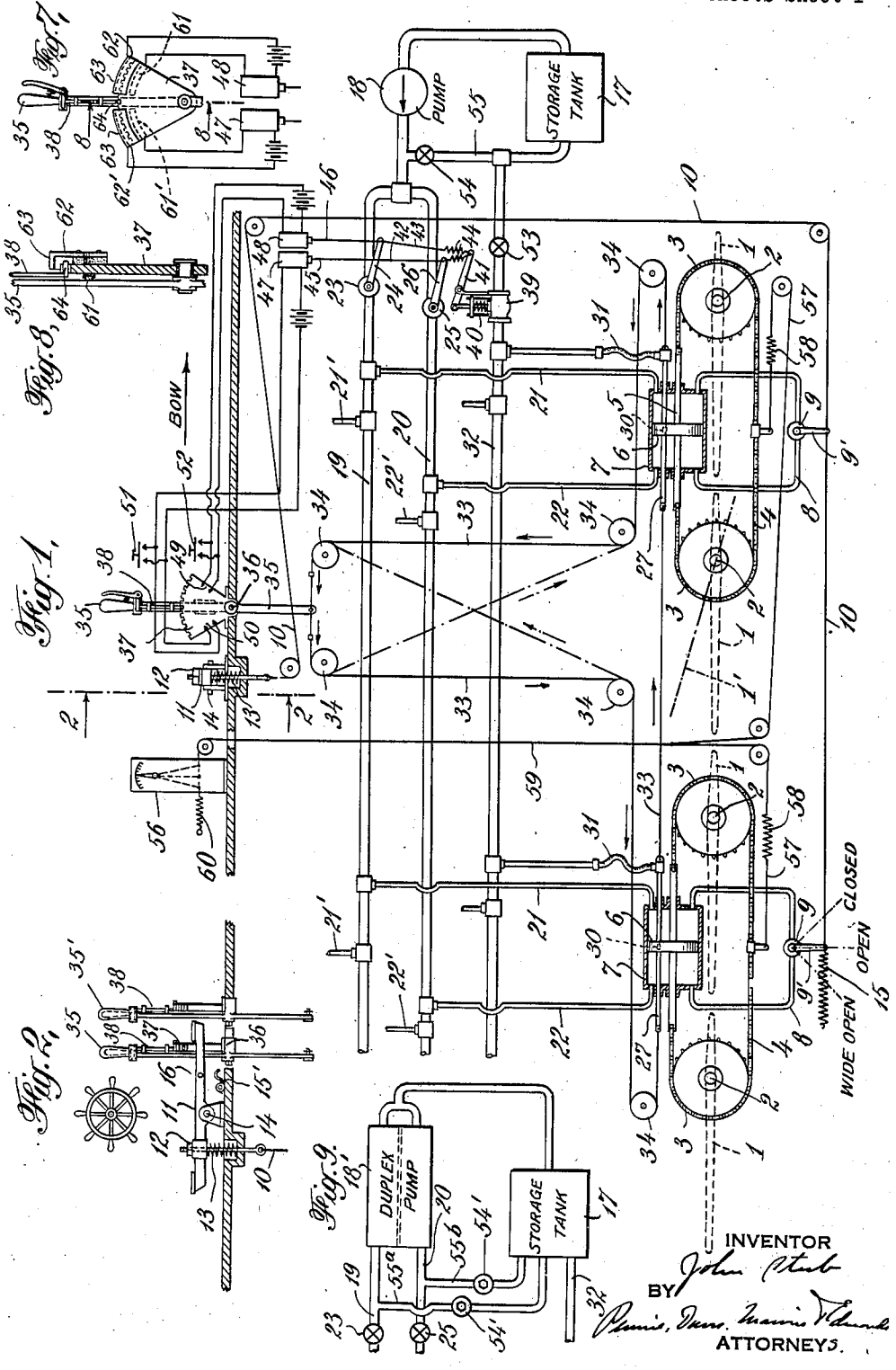
April 11, 1944. J. STUB 2,346,337

SHIP STABILIZING AND CONTROLLING MECHANISM

Filed Nov. 26, 1942 2 Sheets-Sheet 1



INVENTOR
John Stub
BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS.

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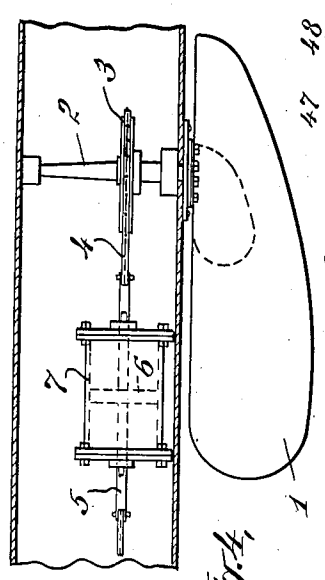


Fig. 4.

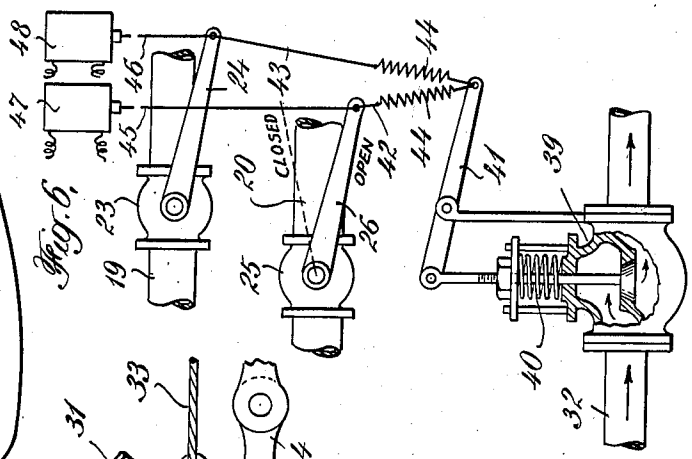


Fig. 6.

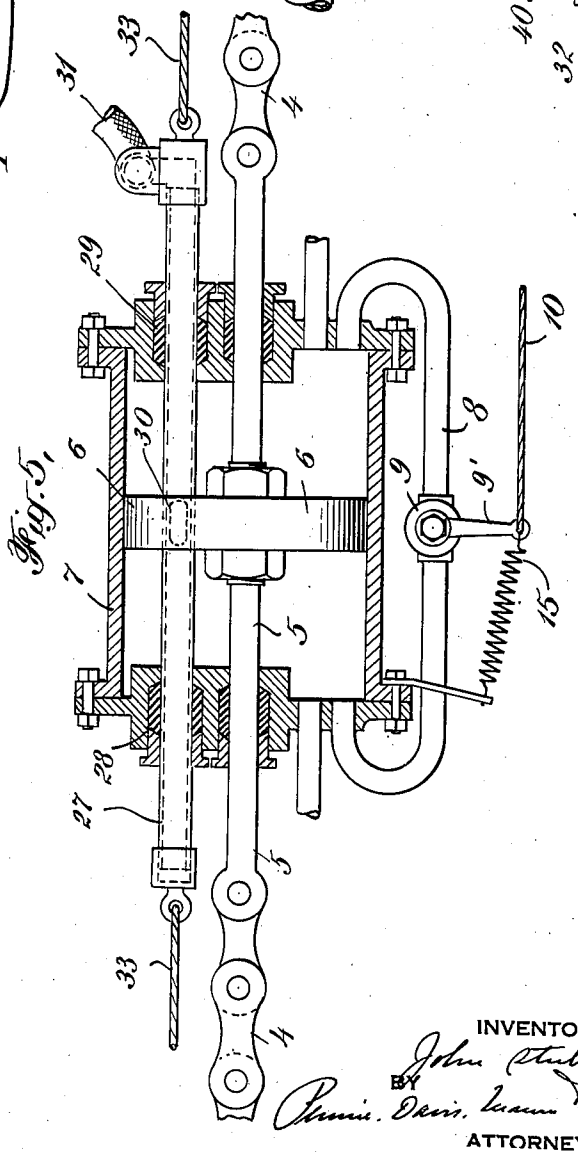


Fig. 5.

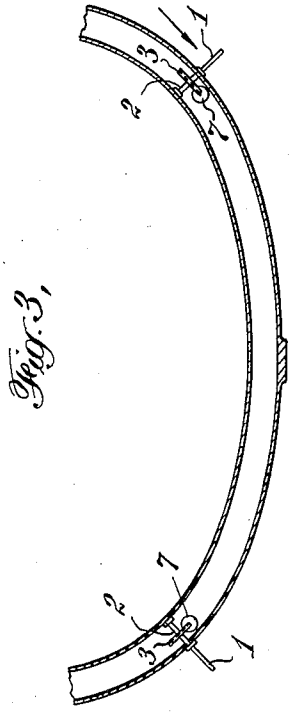


Fig. 3.

INVENTOR
John Stub
BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS

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UNITED STATES PATENT OFFICE

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SHIP STABILIZING AND CONTROLLING MECHANISM

John Stub, East Weymouth, Mass.

Application November 26, 1942, Serial No. 467,035

15 Claims. (Cl. 114—126)

This invention relates to mechanism for stabilizing ships and controlling their movement.

It has been proposed to stabilize ships by equipping them with fins pivotally mounted at the sides of the ship and adjusting the position or inclination of the fins either automatically or by manually controlled means to oppose rolling and pitching of the ship. When the ship rolls to one side the fins are adjusted to so incline them that the leading edge of the fins on the descending side of the ship are elevated with respect to the trailing edge and so that the fins on the ascending side of the ship are oppositely inclined. The forward motion of the ship will then cause the water to exert a lifting force on the fins at the descending side of the ship and a depressing force on the fins at the ascending side to oppose the roll. My invention relates to stabilizing systems of this general type but is an improvement thereon and distinguishes therefrom in the respects hereinafter pointed out.

So far as I am aware most of the known systems of the above described type in which the fins are adjusted automatically have depended for the automatic operation on the use of a gyroscope or pendulum, or the like, located inside the ship, the angular movement of the ship relative to the gyroscope or pendulum being utilized to cause a change in the position of the fins. In those cases where the fins are adjustable by manually controlled means the system has been complicated and expensive.

It has been proposed to make the fins self-adjusting by the action of the water on a control plate associated with each fin. Such a system requires fins and associated parts of special design which adds to the cost, and the adjustment of the fins indirectly by the action of the water on the control plates makes the operation of the system less certain and less reliable than if the fins were adjusted by the action of the water directly upon them.

According to the present invention, when the system is operating as an automatic one, the fins are self-adjusting, no gyroscope or pendulum or similar device being employed. As distinguished from the self-adjusting fins heretofore proposed the fins of my system are automatically adjusted by the direct action of the water upon them, no control plates on the fins being necessary. However, simple adjustable means are provided within the ship to govern the speed of movement of the fins and their resistance to deflection by the forces acting upon them so that they operate in proper timed relation to the rolling of the ship. As a consequence, under normal operating conditions in fair weather, the forces acting on the fins return them substantially to neutral (horizontal) position approximately when the ship reaches even-keel, and during the last half of a roll (from even-keel to maximum heel) the vertical pressure component on the fins, due to the rolling motion of the ship, will gradually deflect the fins from neutral position to an anti-roll position. During the first half of the succeeding roll (from maximum heel to even-keel) the fins will have an inclination in the proper direction to cause the action of the water on the fins, brought about by the forward movement of the ship, to oppose the first half of the roll, during which time the forces acting on the fins will gradually return them to neutral position. The roll is therefore checked in its incipiency and the rolling momentum of the ship which is usually responsible for the full-heel to one side, is reduced, thus making it immaterial that during the last half of a roll the fins are not in an anti-roll position but are being brought to that position.

The stabilizing system according to the invention is also capable of operating in what might be termed a semi-automatic fashion. To this end I provide simple manually operable means for either quickly locking the fins against further deflection by the water, or for so freeing their action that they may very quickly respond to the forces acting upon them. In rough weather, during a hard roll, the helmsman may therefore quickly render the fins rigid to intensify the holding back of the counter-roll. When the counter-roll is near completion he may quickly release the fins and give them greater-than-normal freedom of movement and allow them to quickly change to an inclination in the proper direction to oppose the beginning of the succeeding roll.

The system is also convertible to one in which the fins may be adjusted by simple and relatively inexpensive manually controlled power operated means within the ship. In confused seas the helmsman may then bring about adjustment of the fins to suit the occasion at any particular time. He may also adjust the fins to aid in making quick turns.

The manually controlled power operated means may be easily and quickly converted so as to be capable of effecting movement of the fins at one side of the ship independently of those at the other side. This may be desirable in emergency steering, for instance, in case the regular rudder and propellers on one side are damaged. In using the fins to steer the ship it may be desirable to

incline the fins at the inside of the turn and set the fins at the outside of the turn straight or horizontal. Individual adjustment of the fins at opposite sides of the ship will permit this.

The fins may also be employed to reduce pitching as is well understood in the art. In this case they may be controlled either manually or automatically. If they are manually controlled the fin-adjusting mechanism should preferably adjust the bow fins at opposite sides of the ship so that during their adjustment they are always inclined in the same direction. A simple change in the operating mechanism will cause adjustment of the fins in this manner as will later appear.

My stabilizing and controlling mechanism may also be used on submarines. When so used it may likewise be preferable to operate the fins in such a way that during adjustment the fins on the port side have the same direction of inclination as those on the starboard side to permit quick diving, or submerging and emerging.

My improved stabilizing and controlling mechanism is illustrated in the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of the system, the upper portion of the figure representing the deck at the control station in vertical longitudinal section taken at the center line of the ship looking to port, and the lower portion of the figure being a plan view partially in section at or below the inner bottom of the ship showing the servo-motors, fins, etc., at the starboard side, and the storage tank, pump and piping at or near the center line of the ship.

Fig. 2 is a section taken on the line 2—2 of Fig. 1 and shows the control levers in elevation as viewed when looking toward the bow of the ship;

Fig. 3 is a transverse section through the lower portion of a hull of a ship showing the preferred location of the fins;

Fig. 4 shows one of the fins, and some of the parts immediately adjacent to it, as viewed in the direction of the arrow in Fig. 3;

Fig. 5 is a longitudinal section through one of the cylinders and pistons that operate the fins or control their movement;

Fig. 6 is an enlarged view of a portion of the system shown in Fig. 1, the check-valve being shown partly in section;

Fig. 7 shows a modification of the way in which the movement of the hand lever in Fig. 1 may be utilized to energize one or the other of the valve-controlling solenoids;

Fig. 8 is a partial vertical section taken on the line 8—8 of Fig. 7, and

Fig. 9 diagrammatically illustrates a modification of a part of the fluid supply system shown in Fig. 1.

The fins are indicated at 1. They are preferably mounted at each side of the ship along the bilge and may be used in place of the usual bilge keels, or in place of certain portions of them. Any desired number of fins may be employed at each side of the ship or on the keel. Fig. 1 shows a group of four fins which may be located at one side of the ship (the starboard side) and a corresponding group may be located at the port side.

Each fin may have the shape shown in Fig. 4 and may be rigidly mounted on a shaft 2 journaled in the inner and outer skins of the hull, as shown in Figs. 3 and 4.

In the illustrated embodiment of the invention the fins are coupled in pairs, two pairs of the fins being shown in Fig. 1.

Each fin shaft carries a sprocket 3. A chain 4 passes around the two sprockets of each pair of fins (Fig. 1). The chain is fastened at its ends to a piston-rod 5 attached to a piston 6 which operates in a cylinder 7 (see also Fig. 5).

A by-pass conduit 8 communicates with the cylinder spaces at opposite sides of the piston 6, and is controlled by an adjustable valve 9. All of the valves 9 at both sides of the ship may be simultaneously adjusted by means of a cable 10 which is operatively connected to the operating arm 9' of each valve and which extends to the control station where it is connected to one end of a foot pedal 11 (Figs. 1 and 2). As best shown in Fig. 2 the end of the cable 10 is connected to an eye bolt which passes through the deck and loosely through the left end of the pedal 11 (as viewed in this figure) and is provided with an adjustable nut 12 located above the pedal. A spring 13 biases the pedal 11 in a clockwise direction about its pivotal support 14 and thus tends to exert tension on the cable 10. A spring 15 acting on the opposite end of the cable at each side of the ship (Fig. 1) balances the action of the spring 13 and normally maintains the valves 9 in an intermediate open position in which the valve arms 9' are in the position shown in Fig. 1. When the helmsman depresses the left end of the pedal 11 and compresses the spring 13 the springs 15 move the valve arms 9' to the extreme left hand position in which the valves 9 are fully open, as indicated by the dotted line labeled "Wide-open" in Fig. 1. Similarly if the helmsman removes his foot from the left end of the pedal 11 and depresses the right end thereof the pedal will pull on the cable through the nut 12 and will move the valve arms 9' to the extreme right hand position in which the valves 9 are fully shut, as indicated by the dotted line labeled "Closed" in Fig. 1. The right end of the pedal 11 may be maintained in its depressed condition to keep the valves 9 closed in any suitable way. For instance, a hook 15' may be provided adapted to be placed over the right end of the pedal or through an opening 16 therein to keep the right end of the pedal depressed as long as desired.

Fluid, such as oil, is supplied to the cylinders 7 from a storage tank 17 by means of a pump 18. The pump delivers the oil from the storage tank to two supply conduits 19 and 20. Conduit 19 supplies fluid by means of branch pipes 21 to the right ends of the cylinders located at one side of the ship and conduit 20 supplies fluid by means of the branch pipes 22 to the left end of these cylinders. Similarly the conduits 19 and 20 supply fluid through pipes 21' and 22' to the right and left ends respectively of the cylinders (not shown) at the opposite side of the ship.

The conduit 19 is provided with an adjustable supply valve 23 operated by means of an arm 24, and a similar adjustable supply valve 25 is provided in the conduit 20 operated by means of an arm 26. When the arms 24 and 26 are in the position shown in Fig. 1 the supply valves 23 and 25 are open.

Passing longitudinally through each cylinder 7 is a control tube 27. As best shown in Fig. 5 the tube is somewhat longer than the cylinder and is mounted for longitudinal sliding movement in stuffing boxes 28 and 29 in the cylinder heads. About half way between its ends the tube 27 is provided with a port 30 which constitutes an exhaust port for the fluid in the cylinder.

The tube passes through the piston 6 and when the piston covers the port 30 no fluid can pass from the cylinder into the tube 27. However, when the tube 27 is moved longitudinally in one direction or the other the port 30 is exposed and fluid can then pass into the tube 27 from the cylinder space at that side of the piston at which the port is exposed but not from the space at the other side of the piston. The ends of the tube 27 are closed but a flexible conduit 31 communicates with one end of the tube. All of the flexible conduits deliver the fluid admitted to the sliding control tubes 27 to a return conduit 32 (Fig. 1).

As shown in Fig. 1 the several control tubes 27 at one side of the ship are connected to an operating cable 33 which passes around pulleys 34 and is then connected at its ends to the lower end of a hand lever 35 located at the control station. This lever may be pivoted intermediate its ends at 36 and be provided with a familiar type of quadrant 37 and hand operated latch 38. Forward movement of the hand lever 35 will move the cable 33 in the direction of the arrows shown in Fig. 1 to thereby slide the two control tubes 27 shown in Fig. 1 to the right and backward movement of the hand lever will move the cable in the opposite direction to slide these control tubes to the left. The corresponding cable for the control tubes at the other side of the ship may be crossed before its ends are connected to the hand lever 35, as indicated by the dot-and-dash lines, so that the forward movement of the lever will slide the tubes 27 at the other side of the ship in the opposite direction.

The return conduit 32 is provided with a check valve 39 which is biased toward its closed position by means of a spring 40. This valve is designed to open at a given pressure of the exhaust fluid, say 10 pounds. The stem of the check valve operates a pivoted lever 41 (see also Fig. 6) the free end of which is connected by means of cables 42 and 43 to the arms 26 and 24 of the supply valves in the supply conduits. A coil spring 44 is interposed somewhere in the length of each cable 42 and 43. The arms of the supply valves are also connected by means of cables 45 and 46 to two solenoids 47 and 48 respectively. When the hand lever 35 is in its extreme forward position it closes a pair of electric contacts diagrammatically represented at 49 in Fig. 1 to complete a circuit to the solenoid 48. Similarly when the hand lever 35 is in its extreme rearward position it closes a pair of electric contacts 50 to complete a circuit to the solenoid 47. The circuit of the solenoid 47 may also be completed by means of a push button switch 51 located at the control station, and the circuit of the solenoid 48 may be similarly completed by means of a push button switch 52 also located at the control station. The arrangement is such that when the check valve 39 is moved to its closed position by means of the spring 40 the lever 41 pulls on the cables 42 and 43 through the coil springs 44 to open the supply valves 23 and 25. When the check valve 39 opens, the valve arms 24 and 26 are released so that either valve may then be closed by its solenoid upon movement of the hand lever 35 to one extreme position or the other, or by pressing one of the push buttons. A cable (not shown) may be attached to each valve arm 24 and 26 and may extend to the control station so that either or both of the valves 23 and 25 may be closed and held closed.

A manual shut off valve 53 is preferably located in the turn conduit 32 beyond the check valve 39, and a relief valve 54 is preferably provided in a by-pass 55 (Fig. 1) which extends from the delivery side of the pump to the storage tank. This relief valve opens at some predetermined pressure, say 200 pounds, when the system is being operated as a manually controlled one and when fluid is being delivered under relatively high pressure to the cylinders to actuate the fins.

The operation of the system as thus far described will now be explained.

To place the system in condition for automatic operation in which the fins are self-adjusting, the pump 18 is started, and since the supply valves 23 and 25 are open, fluid will be supplied to both ends of each cylinder 7. The hand lever 35 is then moved forward or backward to shift all of the control tubes 27 and thereby move the exhaust port 30 of each tube to one side or the other of the corresponding piston. Some of the fluid will then escape through the exhaust ports of the control tubes and will be conducted to the return conduit 32. It should here be noted that when a control tube is moved to shift its exhaust port to one side of a piston, the excess pressure of the fluid on the other side of the piston will cause the piston to move until it again covers the exhaust port in the control tube whereupon the piston comes to rest. For this reason, when the hand lever 35 is first moved as above described, the discharge of fluid into the return conduit 32 may be brief and not sufficient to completely fill the return line should the return line be empty or nearly so. It may therefore be necessary when the system is first put into operation to move the hand lever 35 to several different positions until the return line is full and the pressure is built up to 10 pounds whereupon the check valve 39 will open. The hand lever 35 may then be moved to its central position which will cause all of the pistons in the cylinders to assume their central positions. The pump is now stopped, the supply valves 23 and 25 are closed and locked in their closed position as by means of the cables heretofore referred to, the hand lever 35 is moved back and forth a few times to reduce the high (200 lb.) supply pressure to the level of the low (10 lb.) discharge pressure, and the valve 53 is then closed (by suitable means operable from the control station if desired).

Each cylinder and piston now acts as a dash-pot to oppose and retard movement of the fins caused by rolling of the ship. When the ship rolls to one side, the fins at that side of the ship will be deflected due to the relative movement between the water and the ship, and the fins at this side of the ship will be inclined in such a direction that the leading edge of each fin will be lower than the trailing edge. In other words, each fin on the descending side of the ship will point downwardly. The movement of the two fins that are coupled together will move the corresponding piston 6 in its cylinder and this will force fluid from one end of the cylinder to the other through the by-pass 8. The valve 9 in each by-pass restricts the flow of fluid through the by-pass and the amount of restriction is determined by the adjustment of the valve. When the valves 9 are in the intermediate position, indicated in Fig. 1 (permitted by the normal position of the pedal 11), they are adapted to retard the movement of the fins to the right degree to stabilize the ship against the average roll in fair weather. The dash-pot arrangement, as

adjusted, causes the fins to operate in proper timed relation to the rolling of the ship. When the ship is at even-keel the fins should be in their neutral or horizontal position and are always brought back approximately to this position as the ship moves to even-keel. Assuming that the ship is making a roll to port from its maximum heel to starboard and that the roll has been half completed and the ship has reached even-keel position, then during the last half of the roll, from even-keel to maximum heel to port, the fins at the port side will be moved by the forces acting upon them and will be inclined downwardly, i. e., the leading edge of each fin will be lower than the trailing edge, as indicated by the dotted line 1' in Fig. 1. The movement of the fins will be gradual due to the dash-pot action until they have reached their maximum inclination at the end of the roll to port. During this half of the roll the fins are thus being moved to their anti-rolling position and have no effect in opposing the roll. However, during the first half of the succeeding roll to starboard the fins oppose the roll because the forward motion of the ship causes the water to act on the fins in a direction which tends to prevent the port side of the ship from rising. The forces acting on the fins gradually return them to neutral position which is reached approximately when the ship arrives at even-keel. During the last half of the roll to starboard from even-keel the fins at the port side are gradually moved to their anti-rolling position in preparation to oppose the next succeeding roll. It will be understood that during the movement of the ship in the illustration just given the fins at the starboard side will operate in a similar manner but, of course, when a port fin moves in one direction the corresponding starboard fin will move in the opposite direction and assume an inclination in the opposite direction.

For rough weather and hard rolling the system may be operated in what may be termed a semi-automatic fashion. In a hard roll, the helmsman will press on the right end of pedal 11 (as viewed in Fig. 2) and this will move the valves 9 to their fully closed position. The fins will then be locked against movement and will remain rigid to intensify the holding back of the counter-roll. Ordinarily the helmsman will first allow the hard roll to one side to move the fins at that side of the ship to their maximum inclined position, and will then press on the pedal 11 as above described to render the fins rigid so that during the first half of the succeeding counter-roll the fins will exert their maximum anti-rolling effect. When the roll is about three quarters or more completed the helmsman will depress the left end of the pedal 11 and this will allow the springs 15 to move the valves 9 to their wide open position so that the fins will be immediately freed and will be quickly moved to the proper position to oppose the first half of the next succeeding roll.

It will now be noted that when my system is operating in an automatic or semi-automatic fashion the operation differs from stabilizing systems heretofore proposed in that the fins are not moved by power operated means within the ship but are allowed to assume the position which the rolling motion of the ship causes them to assume, and the fins are moved by the direct action of the water upon them and not by an indirect action as is the case when a control plate or the like is associated with each fin. The desired anti-rolling action is obtained by so opposing the movement of the fins that they operate in the proper timed relation to the rolling of the ship to bring about the peculiar operation and anti-rolling action heretofore described.

Nevertheless, when desired, my system may be so operated that the fins are adjustable by manually controlled power operated means within the ship. It may be desirable to operate the system in this fashion in confused seas, for fast turns or emergency steering, or for controlling the fins when used on a submarine. To place the system in condition for this kind of operation the supply valves 23 and 25 are unlocked and they move to open position because the check valve 39 is now closed. The valve 53 is opened, the pump is started, and the right end of the pedal 11 (as viewed in Fig. 2) is depressed and is locked in this condition by means of the hook 15'.

This will move all of the valves 9 to their closed position and lock them closed. The bypass 8 of each cylinder is thus thrown out of operation. The fins may now be adjusted at the will of the helmsman to suit the occasion at any particular time by moving the hand lever 35. When the hand lever is moved to a certain position to move the exhaust port 30 of each control tube to one side of the corresponding piston, the fluid admitted to the cylinder 7 will move the pistons until the exhaust ports 30 are again covered by the pistons, and thus the fins will be adjusted to a position corresponding to the position to which the hand lever 35 is moved. The particular fluid supply system shown in Fig. 1 may cause more fluid to be supplied by one of the supply conduits to that end of each cylinder at which the exhaust port is uncovered than is supplied by the other supply conduit to the other end of each cylinder and thereby reduce somewhat the pressure at which the fluid is admitted to the cylinders by said other conduit. This may cause greater delay in the movement of the fins than if the supply of fluid to the end of each cylinder where the exhaust port is exposed is temporarily cut off.

In order to accomplish this, say on a hard roll to starboard when it is desired to quickly set the starboard fins pointing downward and the port fins pointing upward to check the counter-roll, the hand lever 35 is first moved forward to its extreme position. This moves the control tubes 27 at the starboard side of the ship (the control tubes shown in Fig. 1) to the right. As soon as the exhaust ports 30 are uncovered fluid rushes to the return conduit 32 and the check valve 39 opens. This releases the supply valves 23 and 25 so that either may then be closed by its corresponding solenoid. When the hand lever 35 reaches its extreme forward position the contacts 49 are closed and the solenoid 48 is energized to close the supply valve 23. The pistons 6 move quickly to the right until they again cover the exhaust ports 30 and during this time the fluid continued to exhaust from the right end of the cylinders while none was admitted to take its place. When the check valve 39 again closes it pulls the valve 24 to its open position. The hand lever 35 may now be moved to the desired position corresponding to the inclination which it is desired to give to the fins.

If the contacts which control the solenoids 47 and 48 are associated with the hand lever in some such manner as illustrated in the modi-

fication of Figs. 7 and 8, the proper solenoid may be energized upon movement of the lever to its desired position without first moving it to an extreme position. According to this modification the quadrant 37 of the hand lever is insulated from the lever and carries a pair of segmental contacts 61 and 62 at one side of the neutral position of the lever, and a similar pair 61', 62' at the other side, all of these contacts being insulated from the quadrant. When the contacts 61 and 62 are bridged a circuit is completed to the solenoid 48, and when the contacts 61' and 62' are bridged a circuit is completed to the solenoid 47. The contacts 61 and 61', are on the face of the quadrant facing the lever and one or the other is adapted to be engaged by the lever upon movement of the lever in either direction from its neutral position. The contacts 62 and 62' are carried by the opposite face of the quadrant and each has a flange 63 which projects over the pawl 64 in position to be engaged by the pawl when the lever is moved from its neutral position and the handle is gripped hard enough to move the pawl to the upper limit of its movement. It will be observed from Figs. 7 and 8 that when the hand lever is moved forwardly to any position and the handle is gripped to move the pawl to the upper limit of its movement a circuit will be completed to the solenoid 48 to close the supply valve 23 and when the lever is moved rearwardly and the handle is gripped to move the pawl to its upper limit of movement a circuit will be completed to the solenoid 47 to close the supply valve 25.

In a similar manner the contact of the pawl with the notches in the quadrant may be made to open the valves 23 and 25 and thus relieve the check valve 39 of this function.

Momentary closing of one of the supply valves to cut off the supply of fluid to that end of each cylinder at which the exhaust port 30 is exposed may be avoided altogether if the fluid supply system is constructed as shown in the modification of Fig. 9. In this modification the pump is a duplex one as diagrammatically represented at 18'. A by-pass pipe 55a communicates with the supply conduit 19 on the pump side of the supply valve 23 and leads back to the storage tank. A similar by-pass pipe 55b communicates with the supply conduit 20 on the pump side of the supply valve 25 and leads back to the storage tank. In each of these by-pass pipes there is a pressure relief valve 54'. With this arrangement the pressures in the two supply conduits are independent of each other so that when the exhaust ports 30 are exposed and the pressure is thereby lowered in the supply conduit supplying fluid to that end of each cylinder at which the exhaust port is exposed, pressure will not be stolen from the other supply conduit.

It will be understood that when the hand lever 35 is moved forwardly to shift the control tubes at the starboard side to the right (as viewed in Fig. 1) and thereby adjust the starboard fins to a downward inclination, the control tubes at the port side are simultaneously moved in the opposite direction to cause the port fins to move to an upward inclination, due to the fact that the ends of the cable which actuates the control tubes at the port side are crossed before they are connected to the hand lever 35 as above described. Of course movement of the hand lever 35 to the rear as viewed in Fig. 1 causes upward inclination of the starboard fins shown in Fig. 1 and downward inclination of the port fins.

When the fins are manually controlled it is not so important that the helmsman know the actual position of the fins, because they will always move to a position corresponding to the position to which the hand lever 35 is moved, but for automatic and semi-automatic operation it is advisable to have an indicator to indicate their position. Such an indicator is illustrated diagrammatically at 56 in Fig. 1. It may be operated in any suitable way from the mechanism which operates the fins to give an indication of the position assumed by them at all times. For instance, each of the chains 4 may be connected by means of a cable 57 and coil spring 58 to a cable 59 connected to the indicator. A coil spring 60 associated with the indicator pulls upwardly on the cable 59. The arrangement is such that the indicator gives an indication of the average position of the fins.

For manual adjustment of the fins to prevent rolling, and in facilitating quick turns of the ship, only one hand lever 35 need be used because the operating cables for the control tubes at both sides of the ship may be connected to the single lever and simultaneously actuated as above described. However, for emergency steering, during which it may be desirable to set the fins on the inside of the turn at a certain inclination and set those on the outside of the turn straight or horizontal, there is a second hand lever 35' (Fig. 2) to which the control cable for the fins at one side of the ship may be quickly transferred. To facilitate this each control cable may be detachably connected with the lower end of the hand lever 35 in any suitable way so that either one may be quickly detached therefrom and then attached to the lower end of the second hand lever 35'. In this way the fins at one side of the ship may be adjusted by moving one of the hand levers and the fins at the other side of the ship may be independently adjusted by moving the other hand lever. This arrangement may also be employed when the fins are used on a submarine so that the fins may be inclined in the same direction at both sides of the ship for quick diving, or submerging and emerging, with complete control of inclination or trim at all times. Another way to obtain duplicate action of the fins on both sides of the ship is to uncross the crossed cable 33 and operate both cables from the same hand lever.

In the case of a large ship and many cylinders the moving of many control tubes by the hand lever may not be practical. In this case the hand lever may operate one control tube in a cylinder whose piston is not connected to any fin, and the movement of that piston may be utilized to operate the control tubes in the cylinders whose pistons actuate the fins.

It will now be seen that the mechanism is flexible in its operation in that it permits full automatic operation of the fins, or semi-automatic operation thereof, or operation of the fins by manually controlled power operated means, in the nature of servo-motor mechanism. The cylinders and pistons of the servo-motors also serve as parts of the dash-pots to yieldingly retard movement of the fins when the servo-motor mechanism is rendered inoperative and when the valves in the by-passes of the dash-pots are open and when the system is thus operating in the automatic or semi-automatic fashion. The fins may be employed to give greater stability to the ship in fair weather without any attention on

the part of the helmsman (automatic control), or in rough weather to oppose hard rolling (semi-automatic control), or in confused seas when the helmsman may wish to adjust the fins himself to suit the occasion at any particular time (manual control). When the fins are being manually controlled, they may be simultaneously adjusted but in opposite directions at the port and starboard sides, or the fins on one side of the ship may be adjusted independently of those on the other side as hereinbefore described.

The system for operating fins or rudders hereindescribed may, if desired, be used as the regular ship steering gear, and may also be used on aeroplanes to operate such parts as the horizontal and vertical rudders.

My improved servo-motor mechanism which has been described as part of a system for stabilizing ships and controlling their movement may be used with advantage in other relations where it is desired to produce by remote control movements for definite distances. The piston of my motor is under positive remote control and a small movement of the piston may be utilized to produce, by common means, a much larger movement somewhere else.

Considering the many ways in which my system may be utilized and operated, and its many advantages, it is relatively simple and inexpensive.

I claim:

1. Apparatus for stabilizing and controlling the movement of ships comprising at least one fin pivotally mounted at each side of the ship and means for yieldingly opposing and retarding movement of the fins in either direction and from any position caused by the forces acting on them during rolling of the ship.

2. Apparatus for stabilizing and controlling the movement of ships comprising at least one fin pivotally mounted at each side of the ship, and adjustable means for yieldingly opposing and retarding movement of the fins in either direction and from any position caused by the forces acting on them during rolling of the ship.

3. Apparatus for stabilizing and controlling the movement of ships comprising at least one fin pivotally mounted at each side of the ship, and means for yieldingly opposing and retarding movement of the fins caused by rolling of the ship to a degree such that the movement of the ship from even-keel to full heel gradually brings the fins from neutral position approximately to an anti-roll inclination which will oppose the return movement of the ship from full heel back to even-keel and such that during said return movement of the ship the fins will gradually return to neutral position and reach neutral position approximately when the ship reaches even-keel.

4. Apparatus for stabilizing and controlling the movement of ships comprising a fin pivotally mounted at one side of the ship, and means for yieldingly opposing and retarding the movement of the fin caused by the forces acting on it during rolling of the ship, said means comprising a cylinder, a piston operating therein, connections between the fin and the piston whereby movement of the fin causes movement of the piston within the cylinder, a restricted by-pass placing the cylinder spaces at opposite sides of the piston in communication with each other, and fluid within the cylinder some of which is forced through the restricted by-pass when the piston moves in either direction in the cylinder.

5. Apparatus for stabilizing and controlling the movement of ships comprising a fin pivotally mounted at one side of the ship, and means for yieldingly opposing and retarding the movement of the fin caused by the forces acting on it during rolling of the ship, said means comprising a cylinder, a piston operating therein, connections between the fin and the piston whereby movement of the fin causes movement of the piston within the cylinder, a by-pass connecting opposite ends of the cylinder, fluid within the cylinder some of which is forced through the by-pass when the piston moves in either direction in the cylinder, and an adjustable valve in the by-pass whereby the flow of the fluid through the by-pass may be stopped or the resistance to such flow of the fluid through the by-pass may be varied.

6. Apparatus for stabilizing and controlling the movement of ships comprising a pair of fins pivotally mounted at one side of the ship, and means for yieldingly opposing and retarding the movement of the fins caused by the forces acting on them during rolling of the ship, said means comprising a cylinder, a piston movable in the cylinder, connections between said piston and both of said fins, a restricted by-pass placing the cylinder spaces at opposite sides of the piston in communication with each other, and fluid within the cylinder some of which is forced through the restricted by-pass when the piston moves in either direction in the cylinder.

7. Apparatus for stabilizing and controlling the movement of ships comprising at least one fin pivotally mounted at each side of the ship, adjustable means for yieldingly opposing and retarding movement of the fins in either direction and from any position caused by the rolling of the ship, and manually operable means located at a control station and operatively connected with said adjustable means for adjusting the same.

8. Apparatus for stabilizing and controlling the movement of ships comprising a fin pivotally mounted at one side of the ship, and means for yieldingly opposing and retarding the movement of the fin caused by the rolling of the ship, said means comprising a cylinder, a piston operating therein, connections between the fin and the piston whereby movement of the fin causes movement of the piston within the cylinder, a by-pass connecting opposite ends of the cylinder, fluid within the cylinder some of which is forced through the by-pass when the piston moves in either direction in the cylinder, an adjustable valve in the by-pass whereby the resistance to the flow of the fluid through the by-pass may be varied or said flow entirely stopped, and manually operable means located at a control station and operatively connected to said valve for adjusting or closing the same.

9. Apparatus for stabilizing and controlling the movement of ships comprising a fin pivotally mounted at one side of the ship, manually controlled servo-motor mechanism within the ship and operatively connected to said fin whereby it may be adjusted to various inclinations at will, said servo-motor mechanism including a cylinder having a fluid-operated piston operatively connected to said fin, a by-pass connecting opposite ends of the cylinder, an adjustable valve in the by-pass, manually operable means located at a control station and operatively connected to said valve whereby the same may be closed when the servo-motor mechanism is utilized to adjust the fin and whereby it may be opened so that

when the servo-motor mechanism is not being utilized the cylinder and piston act as parts of a dash-pot to yieldingly oppose and retard movement of the fin caused by the rolling of the ship, and means to render the servo-motor mechanism inoperative.

10. Apparatus for stabilizing and controlling the movement of ships comprising a fin pivotally mounted at one side of the ship, servo-motor mechanism within the ship and operatively connected to said fin and manually controlled from a control station whereby said fin may be adjusted to various inclinations at will, said servo-motor mechanism including a cylinder having a fluid-operated piston operatively connected to said fin, a by-pass connecting opposite ends of the cylinder, an adjustable valve in the by-pass, manually operable means located at said control station and operatively connected to said valve whereby the same may be closed when the servo-motor mechanism is utilized to adjust the fin and whereby it may be opened so that when the servo-motor mechanism is not being utilized the cylinder and piston act as parts of a dash-pot to yieldingly oppose and retard movement of the fin caused by the rolling of the ship, and means to render the servo-motor mechanism inoperative.

11. Apparatus for stabilizing and controlling the movement of ships comprising at least one fin pivotally mounted at each side of the ship, servo-motor mechanism at each side of the ship and operatively connected to the corresponding fin or fins to adjust them to various inclinations, manually operable means located at a control station for controlling said servo-motor mechanism, said manually operable means comprising an adjustable lever and connections therefrom to the servo-motor mechanism at both sides of the ship and adapted to cause the servo-motor mechanism at one side of the ship to adjust the corresponding fins to an inclination in one direction and to cause the servo-motor mechanism at the other side of the ship to simultaneously adjust the fins at that side of the ship to an opposite inclination.

12. Apparatus for stabilizing and controlling the movement of ships comprising at least one fin pivotally mounted at each side of the ship, servo-motor mechanism at each side of the ship and operatively connected to the corresponding fin or fins to adjust them to various inclinations, manually operable means located at a control station for controlling said servo-motor mechanism, said manually operable means comprising two adjustable levers, connections from one of said levers to the servo-motor mechanism at both sides of the ship and adapted to cause the servo-motor mechanism at one side of the ship to adjust the corresponding fins to an inclination in one direction and to cause the servo-motor mechanism at the other side of the ship to simultaneously adjust the fins at that side of the ship to an opposite inclination, said connections from said adjustable lever being partly transferable and connectible to the second lever whereby the servo-motor mechanism at one side of the ship may be controlled independently of that at the other side and so that the fins at opposite sides of the ship may be independently adjusted.

13. Apparatus for stabilizing and controlling the movement of ships comprising a fin pivotally mounted at one side of the ship, servo-motor mechanism for adjusting the inclination of the fin, said servo-motor mechanism comprising a cylinder, a piston movable therein and operatively connected to the fin, means for admitting fluid under pressure to the cylinder at opposite sides of the piston, a control tube mounted to slide longitudinally back and forth in the cylinder, said piston having an opening through which the control tube passes and the control tube having a port adapted to be closed by the piston, a return conduit in communication with said control tube, and means for shifting the position of the control tube to expose said port and permit fluid to be discharged from one end of the cylinder through said port to the return conduit whereupon the piston will move until it again covers said port.

14. Apparatus for stabilizing and controlling the movement of ships comprising a plurality of fins mounted at the side of the ship, servo-motor mechanism for adjusting the inclination of the fins, said servo-motor mechanism comprising a plurality of cylinders, a piston movable in each cylinder, operative connections between each piston and at least one of the fins, means for admitting fluid under pressure to each cylinder at opposite sides of the piston, a control tube mounted to slide longitudinally back and forth in each cylinder and passing through an opening in the corresponding piston, said control tube being provided with an exhaust port, a return conduit in communication with all of the control tubes, and means for simultaneously shifting the position of all of the control tubes to expose the exhaust port of each tube and permit fluid to be discharged from one end of each cylinder into said return conduit whereupon the piston in each cylinder will move to again cover the exhaust port in the control tube.

15. Apparatus for stabilizing and controlling the movement of ships comprising at least one fin pivotally mounted at each side of the ship, means adapted to yieldingly oppose and retard movement of the fins in either direction and from any position caused by the forces acting on them during rolling of the ship, said means being adjustable to render the fins freely movable or to lock them in position or to vary the extent of opposition to their movement, and manually operable means located at a control station and operatively connected with said means for adjusting the same to free the movement of the fins or lock them in position or to vary the extent of opposition to their movement.

JOHN STUB.