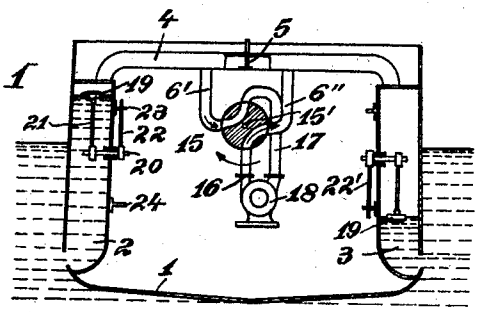
Nov. 22, 1932. H. HORT 1,888,667

STABILIZING DEVICE FOR SHIPS

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Fig. 1



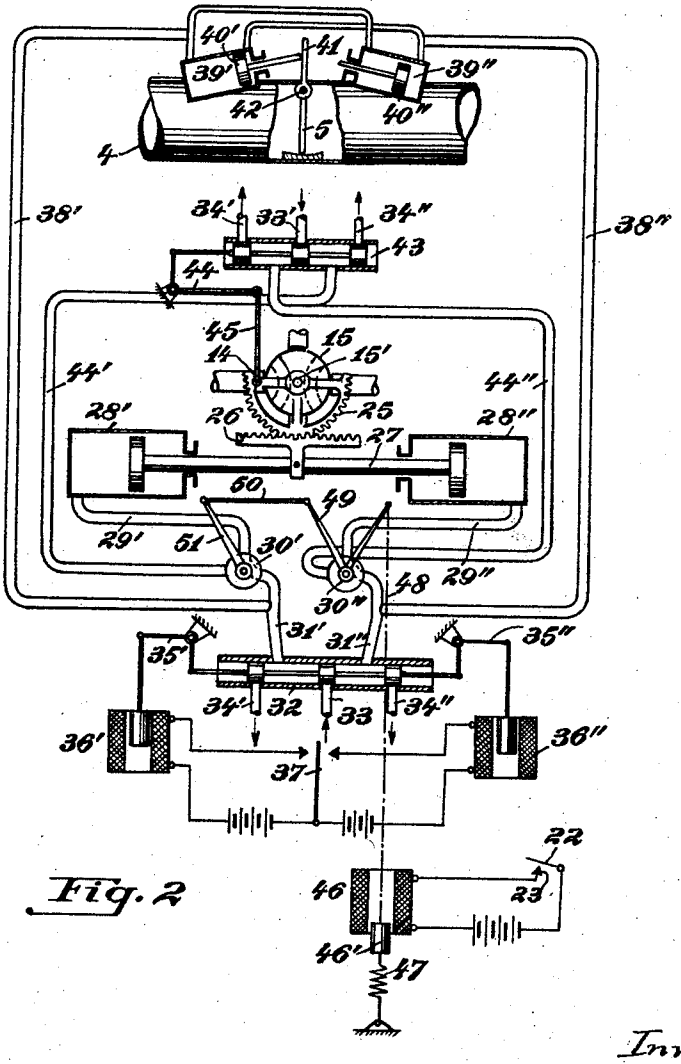


Fig. 2

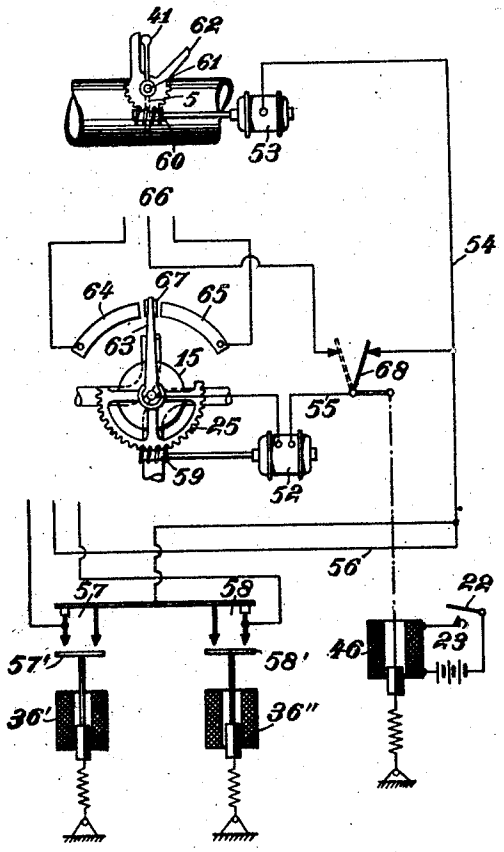
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STABILIZING DEVICE FOR SHIPS

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Fig. 3



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STABILIZING DEVICE FOR SHIPS

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Fig. 6

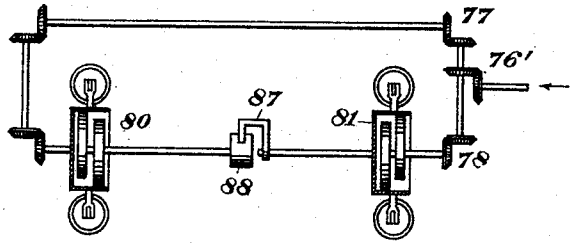


Fig. 7

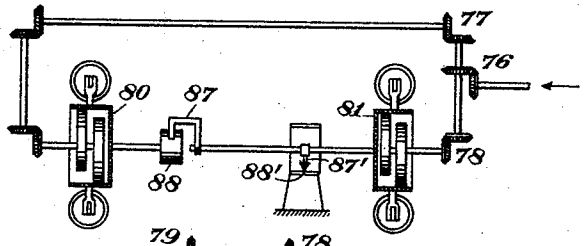


Fig. 4

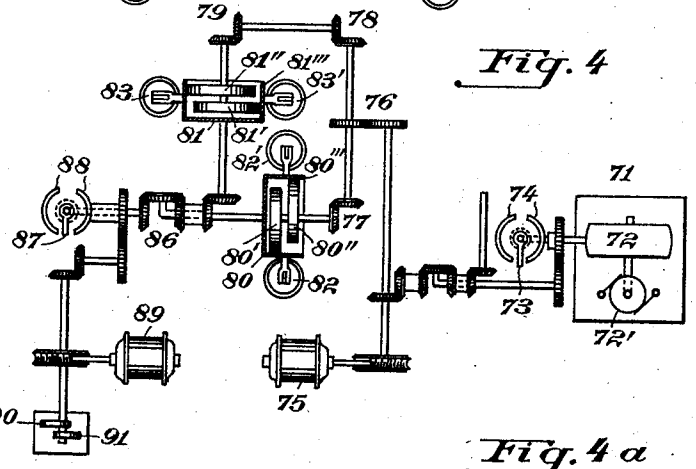


Fig. 5

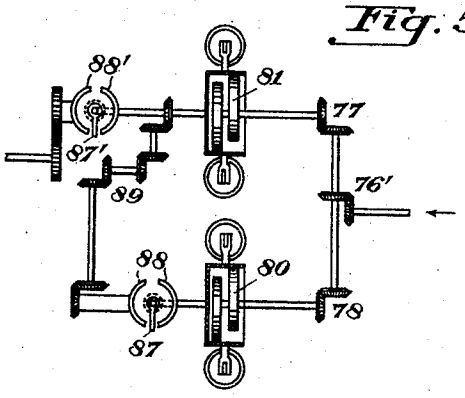
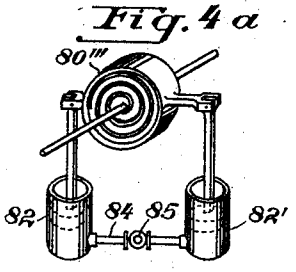


Fig. 4a



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Patented Nov. 22, 1932 1,888,667

UNITED STATES PATENT OFFICE

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STABILIZING DEVICE FOR SHIPS

Application filed October 26, 1931, Serial No. 571,049, and in Germany October 28, 1930.

My invention relates to stabilizing devices for ships, and particularly to devices in which the stabilizing action is obtained by movable weights, generally arranged in pairs, to oppose an oscillating motion of the ship, and the invention is applicable for use as an anti-rolling device, or as an anti-pitching device, depending simply on the relative arrangement of such weights. While weights of solid material may be used in connection with my invention, the preferred form of my invention employs bodies of liquid, and particularly water movable in tanks carried by the ship. The particular embodiments of my invention illustrated in the accompanying drawings and described in detail below, constitute an anti-rolling device for ships. Anti-rolling devices employing tanks are not broadly new, and in connection with such tanks there have been employed valves which at the moment of the reversal of the rolling motion are opened temporarily in order to allow the water to flow out of the tank which is the higher tank at that time and into the temporarily lower tank. After the valves have been closed, the water in the full tank which is located on the raised side of the ship is retained by a sort of pipette action, whereas water in the lower tank is maintained in about its lowest position by the amount of air trapped above it. When the one side of the ship attains its highest position during the rolling motion, the valves are opened whereby the tanks are brought into communication either with each other or with the surrounding air, so that water will flow out of the higher tank and into the lower tank. Thus, at the moments when the rolling motion changes its direction, a certain amount of water will be shifted suddenly from one side of the ship to the other and the weight of this body of water will act as a damping force during the time that the ship rolls in one direction or the other. The amount of this periodically shifted body of water depends on the size of the tanks and it will be obvious that the tanks will have to be very large in order to obtain a sufficient damping action by the above described arrangement alone. Furthermore, the damping action diminishes constantly during the rolling of the ship, because on the higher side of the ship, the water retained by a sort of pipette action will constantly be dropping to a lower level. In order to avoid this drawback and to increase the damping action of the tanks, devices may be provided for artificially producing a vacuum in the space above the liquid in the tank of the higher side, and a compression of air in the tank of the lower side of the ship.

My present invention relates to a particularly efficient arrangement for the purpose indicated above and also to the controlling and actuating devices which govern the operation of the means regulating the action of the tanks. In the embodiments of my invention illustrated herein, the tanks are connected by a pressure-equalizing conduit containing a valve, and this valve is bypassed by a circulation conduit having a pump or other propelling device for assisting the control action of the said valve in such a manner that the propelling device will not be affected by the pressure equalization occurring at the opening of the valve which controls the connecton of the tanks. The cyclic control of the motion of the air or liquid effected by the said valve will therefore occur independently of the cyclic control of the propelling device. By this arrangement I secure important advantages; the sudden pressure equalization between the tanks will not take place through the circulation conduit or the propelling device, and therefore the throttling action during the pressure equalization will be but slight, and a relatively small pump or propelling device may be employed.

The control of the regulating devices in the pressure-equalizing conduit and in the circulation conduit may be effected, according to my invention, with the aid of a control shaft which is set to the proper positions either by a reversible indicating device or preferably by two integrators connected in parallel, both of which are subject to the extent of the rolling motion to be equalized, said integrators being damped to different degrees. This control device will set in one

direction or the other, preferably by electromagnetic means, the mechanical, hydraulic or electric drives provided for the adjustment of the regulating devices of the pressure-equalizing conduit and of the circulation conduit. In order to obtain a very rapid and positive opening and closing of the valve in the pressure-equalizing conduit, and a quick reversal of the flow in the circulation conduit, it is preferable to employ a hydraulic drive for the control devices of these conduits. The control operations for both conduits may be initiated by a piston valve adjustable electromagnetically from the control shaft, this piston valve controlling the suction and delivery conduits leading to the cylinders or hydraulic pistons which serve for determining the position of the valve in the pressure-equalizing pipe and of the controlling valve in the circulation conduit. I also prefer to employ cocks having a plurality of passages or ways, which cocks are thrown into operation according as the water level in the tanks reaches its highest or lowest point, and these cocks disconnect the piston which sets the control valve, from the piston control mentioned above and connect it with a second piston control associated with the control valve and so constructed that the pressure liquid controlled thereby will bring the control valve back to its closed position so as to prevent a further supply or circulation of air or liquid at the moment when the liquid in the tanks has reached its highest or lowest level.

The particular embodiment illustrated employs tanks which have a direct communication with the seat, at their lower portions. I do not, however, wish to restrict myself to this arrangement, but the tanks might be connected by a communication pipe containing water. This pipe might also constitute the pressure-equalizing conduit. In this case the circulation conduit would likewise have to be connected with the lower portions, or water spaces, of the tanks. Of course, it is also possible to control each tank separately, the pressure-equalizing conduit terminating either within the sea or within the atmosphere, while the circulation conduit would be connected on one hand with the air spaces of the tanks and on the other hand with a wind-chest. The use of wind-chests is particularly suitable when the tanks are located very low in the ship, because in this case the pressure existing above the water contained in the tanks need not be equalized relatively to the atmosphere. Thus a much smaller energy will be required for the operation of the pump or other propelling device of the circulation conduit.

Reference is to be had to the accompanying drawings in which Fig. 1 is a diagrammatic cross section of a ship provided with my invention in its embodiment as an anti-rolling device; Fig. 2 is a diagrammatic representation of the mechanism controlling the anti-rolling device, with parts in section; Fig. 3 is a diagrammatic view showing another form of the controlling device; Fig. 4 is a diagrammatic elevation showing still another form of controlling device, Fig. 4ª is a detailed perspective view of some elements forming part of the construction shown in Fig. 4, and Figs. 5, 6 and 7 illustrate modifications of portions of the mechanism shown in Fig. 4.

In Fig. 1 the hull of the ship is indicated at 1, and at 2 and 3 there are shown two tanks located at opposite sides of the ship, the lower part of each tank communicating with the sea. The upper portions of the tanks 2 and 3 are connected by a pipe or pressure equalizing conduit 4 in which is arranged a valve 5 adapted to establish or interrupt the communication between the two tanks. A shunt connection is also provided between the two portions of the pipe 4 located on opposite sides of the valve 5. This shunt connection consists of two circulation conduit-branches 6′, 6″ co-operating with a two-way valve 15, in conjunction with the delivery pipe 16 and the suction pipe 17 of a circulating pump 18 driven continuously by any suitable motor (not shown). The valve 15 is mounted to rotate about its axis 15′ and it will be readily understood that by turning said valve in the direction indicated by the arrow, the connections shown in Fig. 1 can be reversed, that is to say, the suction pipe 16 can be connected with the pipe 6′ and the delivery pipe 17 with the pipe 6″. Each of the tanks 2 and 3 contains a float 19 pivotally connected with an arm 21 rigid on a shaft 20. The height of the water level in each tank, or in other words, the level at which the float is located, is indicated by means of arms 22, 22′ which move in unison with the respective arms 21. The arms 22, 22′ also serve as switch arms, being adapted to engage, in their extreme positions, two stationary contacts 23 and 24 respectively which are connected with certain circuits as explained more fully below.

In order that the bodies of water may be shifted at the proper times, it is necessary that a device which is adapted to hold the valve 5 against movement, be released at the points where the rolling motion of the vessel is reversed, so that the difference in pressures between the two tanks may be equalized through the pipe 4. As soon as this equalization has taken place, the valve 5 will resume its closing position, either simply by gravity or with the aid of springs (not shown) so that during the next half period of the rolling motion, the different levels of the water in the tanks 2 and 3 will remain unaltered. The control valve 15 of the circulation conduit must then be in such a position that the pump

during this half period of the rolling motion will transfer air from the tank 2 into the tank 3, and during this operation, the water will rise in the tank 2 and fall in the tank 3.

Fig. 2 shows a hydraulic mechanism for operating the valve 5 and the control valve 15. The toothed sector 25 is secured rigidly to the body of the valve 15, by fastening such sector on the shaft 15'. With this sector meshes a rack 26 connected rigidly with a piston rod 27 which connects the two pistons 27' and 27'' movable in the stationary cylinders 28' and 28'' respectively. These cylinders are open to the air at the ends where the piston rod 27 passes through them, while at the other ends the cylinders are connected with pipes 29' and 29'' respectively leading to cocks or valves 30' and 30'' respectively which also co-operate with pipes 31', 31'' respectively leading to the casing 32 of a controlling valve having three pistons 32' secured to the same rod 32''. The casing 32 is also connected with suction conduits 34', 34'' and a pressure conduit 33 for the passage of a suitable pressure fluid. In the position illustrated, the three pistons 32' shut off the connections to the conduits 33, 34', 34''. The pistons 32' are controlled, by means of suitable linkage indicated at 35', 35'', by electromagnets or coils 36', 36'' respectively. Thus by shifting the pistons 32', the conduits 31' and 31'' and through them the cylinders 28' and 28'' can be connected either with the pressure conduit 33 or one or the other of the suction conduits 34', 34''. In other words, in one position the cylinder 28' will be connected with the pressure conduit and the cylinder 28'' with one of the suction conduits, while in another position of the valves 32', the reverse condition will be obtained. The energizing of the electromagnets or coils 36', 36'' is controlled by a switch 37 which may be operated in any suitable manner, for instance by the mechanism described below with reference to Figs. 4 and 4a. The operation will be so timed that the electromagnets or coils 36', 36'' will be energized in accordance with the rhythm of the rolling motion, causing a corresponding periodical motion of the pistons 32' first in one direction and then in the other. The energizing of the electromagnets or coils may also be effected in other ways, for instance by the mechanisms shown in Figs. 5, 6 and 7 described below, or by means of a gyroscope responsive to the angular velocity of the ship's rolling motion, the extent of the precession movement of such gyroscope being damped.

The casing 32 of the controlling valve is also connected through the pipes 31' and 31'', with pipes 38' and 38'' leading to cylinders 39', 39'' respectively in which are located pistons 40', 40'' respectively. The rods of these pistons are adapted to engage an arm 41 extending upwardly from the shaft 42 about which the valve 5 is adapted to swing. The pipe 38' is connected with the inner end of cylinder 39'' and with the outer end of cylinder 39', while the reverse connection is employed for the pipe 38''. The pistons 40', 40'' will therefore move in opposite directions and when one of them is in its inner position, the other will be in its outer position. In other respects the movement of the pistons 40', 40'' will correspond to the movement of the pistons 27', 27''.

Fig. 2 also shows an additional controlling valve having a casing 43 and three pistons 43' connected by a piston rod 43''. The casing 43 has ports connecting it with a pressure conduit 33' and suction conduits 34' and 34'', these ports being controlled by the pistons 43'. By means of linkage 44, 45, 14, the pistons 43' are operatively connected with the controlling valve 15 and the sector 25. Thus, any motion of the piston rod 27 will be communicated to the piston rod 43''. If the valves 30', 30'' are thrown into a position different from the one indicated in Fig. 2, a connection will be established between the pipes 29' and 44' on one hand and the pipes 29'' and 44'' on the other hand, said pipes 44' and 44'' leading to the casing 43. In that case pressure fluid may pass from the casing 43 to the cylinders 28', 28'' so as to act on the pistons 27', 27'' and on the controlling valve 15. In the position illustrated, the two-way cocks 30', 30'' have disconnected the casing 43 from the cylinders 28', 28'', and only the controlling valve 32, 32' will be operative at this time. According as the pistons 32' are shifted toward the left or toward the right by the magnets or coils 36'' or 36' respectively, the piston rod 27 will be in its extreme right hand or left hand position respectively. This will connect the pump with the circulation conduit in either one direction or the other so that either the pipe 6' or the pipe 6'' will be connected with the suction port of the pump 18. When the pump has transferred so much air from the tank on one side of the ship to the tank on the opposite side, that the water in one of these tanks will reach its highest or its lowest level, the respective contact 23 or 24 will be engaged by the arm 22 or 22' and this will close a circuit such as the one indicated at the lower portion of Fig. 2, to energize an electromagnet or coil 46. Normally, a spring such as 47 keeps the core 46' of such magnet or coil in an unsymmetrical position as shown. Upon the energizing of the magnet or coil 46, the core 46' will be drawn into a symmetrical position in the well known manner, and this movement of the core 46' will by the connections 48, 49, 50, 51 simultaneously swing the bodies of the two valves or cocks 30', 30'' into the position in which the valve 30' connects the pipes 29' and 44', while the valve 30'' connects the pipes 29'' and 44''. This will, as explained

above, connect the casing 43 with the cylinders 28′ and 28″, and by applying pressure fluid to the outer compartments of both cylinders 28′ and 28″, force the pistons 27′ and 27″ into the median position illustrated, the controlling valve 15 being thereby likewise brought into its median position. The controlling valve 15 will then shut off the circulation conduit from the pump 18 so that further circulation of the fluid will be prevented until the level of the water in the tanks 2 and 3 again rises or falls respectively so that the switch 22, 23 will be opened, whereupon the spring 47 will again reverse the position of the two-way cocks 30′, 30″. Therefore, as long as the floats 19 located in the tanks are between their extreme positions, the cylinders 28′, 28″ will remain connected with the valve casing 32 so that the pistons 27′, 27″ will be moved to and fro in the rhythm of the rolling motion, the said pistons being reversed every time that the rolling motion is reversed. Whenever one of the floats reaches its highest or its lowermost position, the electromagnet coil 46 will be energized, whereby the two-way cocks 30′ and 30″ will be reversed, so that the slide valves 43′ will at once bring the pistons 27′, 27″ and the valve 15 of the circulation conduit into the zero position or shut off position. The pump 18 is then shut off from the circulation conduit. Very soon thereafter the electromagnet coils 36′ and 36″ are reversed, for instance by the control mechanism shown in Fig. 4, and the pistons 32′ are also reversed. This will at once release the valve 5 of the pressure-equalizing conduit, so that the level of the water in the tanks will adjust itself to the water level outside the ship. This causes the floats to move out of their extreme positions. The magnet coil 46 is thus deenergized, the spring 47 reverses the position of the two-way cocks 30′, 30″ and thus the pump is again connected with the circulation conduit to propel fluid therethrough in one direction or the other.

In Fig. 3, I have shown an electric control device in which an electric motor 52 serves to change the position of the control valve 15 of the circulation conduit, while the release or the blocking of the valve 5 located in the pressure-equalizing conduit is effected by an electric motor 53. Both motors 52 and 53 are connected by wires 54, 55, 56 with relays 57, 58 which are bridged by the armatures 57′, 58′ respectively operated by the electromagnet coils 36′ and 36″ respectively. These magnets are energized and deenergized in unison with the rhythm of the ship's oscillations, just as has been described above in connection with Fig. 2; the energizing and deenergizing of the magnets can be controlled, for instance, by the mechanism shown in Fig. 4. The motor 52 operates the toothed sector 25 by means of a worm 58 it being understood that the motor and said worm will rotate in one direction or the other according as either the relay 57 or the relay 58 has been energized. The motor 53 operates by means of a worm 60, a double arm 62 having gear teeth, the abutment arm or lever 41 carried by the spindle 61 of the valve 5 being so located that it will be arrested by one or the other of the two arms 62.

On the hub of the toothed segment 25 is secured a switch arm 63 which upon rotation of the segment 25 will come into sliding engagement with contact plates 64, 65 which are connected with the battery 66; when the valve 5 is in its median neutral position, the switch arm 63 rests on an insulated plate 67. By means of the switch 68 which is operated by the electromagnet 46 energized when the arms 22, 22′ are in their extreme positions, the motor can be disconnected from the relay 57 or 58 and connected with the battery 66 so that the motor will rotate the toothed segment 25 and with it the control valve 15 backward until the switch arm 63 again engages the insulated plate 67, whereby the motor is stopped. This will at the same time disconnect the pump 18 from the branches 6′, 6″ of the circulation conduit.

It would of course also be possible to employ continuously rotating motors for the drive of the toothed segment 25 and of the double arm 62, in which case clutches would have to be provided in the drive of the worms 59, 60, which clutches would have to be thrown in for a short time by the relays 57 and 58.

If instead of the continuously operating pump 18 shown in Fig. 1 in connection with the control valve 15, a regulatable pump should be arranged directly in the circulation conduit, there might be located on the shaft of the toothed segment 25, for instance directly, a switch arm or the like regulating the driving motor of the pump, which switch arm would in that case serve both to reverse the pump and to regulate its speed.

Figs. 4 and 4ª show one embodiment of a mechanism according to the present invention, for actuating the control valve 5 and regulating the fluid propelling device. At 71 I have indicated a device measuring the rolling angle, which device consists of a gyroscope 72 rotating in a normally horizontal plane, and its driving motor 72′. The gyroscope 72 is suspended in a universal joint or gimbal in the well known manner and the deflection of the gyroscope about the outer gimbal axis, which lies longitudinally of the ship, is transmitted to a roll angle indicator 73 which also constitutes a switch arm adapted to engage the contacts 74 which are shifted by the motor 75 and the intermediate connections shown, in a follow-up movement of well known character. The motor 75 operates only when contact is made between 73 and 74 and will then transmit the angle at which

the ship is inclined about the longitudinal axis of the ship, by means of spur wheels 76 and bevel wheels 77, 78, 79 to the two integrators 80 and 81 having spiral springs 80′, 80″ and 81′, 81″ respectively which are wound left and right respectively. The outer ends of these springs are secured to the spring casings 80‴ and 81‴ respectively, and are supported by pistons located in dash-pots 82, 82′ and 83, 83′ respectively. As shown in Fig. 4ª, the two dash-pots of the same integrator are connected by a conduit 84 containing a throttle valve 85.

The throttling of the integrator 80 is adjusted in such a manner that there will be only a slight damping of the movement of the spring casing 80‴ under the influence of the springs 80′, 80″ which are wound or put under strain periodically in accordance with the angle of oscillation of the ship. Therefore, the rocking movements which the spring casing 80‴ transmits to the differential gearing 86 will be relatively large and will reproduce accurately as to amplitude the deflection of the gyroscope 72; in their phase however these movements are shifted relatively to each other more or less approximately by about 90°. On the other hand, the throttling of the integrator 81 is set more strongly so that the spring casing 81‴ will rock to a comparatively slight extent under the influence of the rolling motion of the ship; the rocking of the spring casing 81‴ will be produced only in accordance with the mean rolling angle of the ship, that is to say not the periodical straining of the springs 81′ and 81″, but the one sided straining of the springs which results from the ship having a mean inclined position for a relatively long time. Such movement is transmitted to the differential gearing 86 in such a direction that the contact making pointer 87 will be shifted according to the difference of the two movements. The proportions of the gearing and of the throttling can be selected in such a manner that the integrator 81 will take up or equalize exactly that portion of the deflections or movements of the spring casing 80′ which is due to the mean inclined position of the ship, but if desired, the arrangement may be such that the controlling action due to the integrator 81 will be greater than said portion. It is well known that the ship always has a mean or median inclined position during rolling; such median position can be produced by side wind or by the motion of the waves, by uneven loading, or by the centrifugal forces arising whenever the course is changed. In order to obtain perfectly satisfactory control, it is necessary that these median inclinations be taken into account and that their influence which is liable to render inaccurate the controllng influence of the integrator 80 be at least neutralized. If the integrator 80 alone were employed to set the contact making pointer 87 and if the deflections of this pointer which are reproduced by the motor 89 which produces a follow-up rotary motion of the contacts 88 co-operating with said pointer, were employed to energize (by means of the cam 90) the magnet which operates the switch 37 of Fig. 2, then the bodies of water in the tanks 2 and 3 would be controlled in such a way that, in the mean, the water would be at a higher level in that tank which is lower owing to the inclination of the ship, than in the tank on the other side of the ship. The effect on the windward side of the ship would therefore be increased, and this, of course, is undesirable. Only when the influence which the mean inclination or list of the ship has on the controlling factor due to the integrator 80 has been neutralized in the differential gearing 86 by the strongly damped integrator 81, the masses are controlled about the mean list of the ship in accordance with the periodic deflections of the gyroscope, and will therefore no longer increase the list condition. If the factor due to the control of the integrator 81 is greater than this influence, the result will be that the liquid masses will, as a mean, be shifted more toward the higher side of the ship, so as to counteract and partly reduce the list and thereby increase the stability of the entire ship materially. In the arrangement described above, the factors produced by both integrators control the operation of the valve 5 for effecting pressure equalization in the tanks and also the reversal of the circulation at the moment of the reversal of the rolling motion, or shortly before such reversal. The cam 90 may serve not only for reversing the fan, pump or other propelling device 18, but also for varying the output of such propelling device in accordance with the amount of angular displacement of such tank.

In Fig. 5 there has been indicated a somewhat modified controlling mechanism in which valve 5 and the controlling valve 15 are operated independently of each other. Only the electromagnet for controlling the shut-off valve 5 is to be actuated under the influence of the two integrators with the aid of the contacts 87, 88. The reversal and regulation of the fan or propelling device 18, however, is effected exclusively by the strongly damped integrator 81 which operates the contacts 87′, 88′. The controlling factor due to this integrator is proportional to the mean list of the ship, as has been mentioned above. The propelling device 18 controlled in accordance therewith will, in this case, simply shift the bodies of water to the temporarily higher side of the ship corresponding to this mean list. Therefore, the propelling device may in certain cases be made of smaller dimensions than if it had the additional function of counteracting the rolling motion. The

setting of the integrators 80, 81 according to the list angle is effected by means of bevel gears 76′, 77, 78 similar to the correspondingly designated parts of Fig. 4. The contacts 87, 88 are controlled directly by the integrator 80 and indirectly by way of bevel wheels 89, by the integrator 81.

In order that the values or factors obtained by the integrators may not be affected by the friction or by the acceleration of the train of gears and the like, the arrangement shown in Figs. 4 and 5 may be simplified in the manner illustrated by Figs. 6 and 7. Here, the contacts 87, 88 and 87′, 88′ are set or actuated directly by the damped shafts of the integrators.

The controlling mechanisms described above may also be employed, without any material changes, when the stabilizing is effected by solid bodies, for instance cars, instead of using liquid bodies or tanks, particularly when such solid bodies are actuated hydraulically, for instance by means of telescopic rods. The new control device may, however, also be used for electrically driven cars, for instance by employing the cam 91 shown in Fig. 4 for controlling the regulating member or switch of the motor driving such car.

I claim:

1. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a valve controlling said conduit, a circulation conduit connected with the first named conduit and by-passing said valve, a fluid propelling device connected with said circulation conduit, and means for controlling said fluid propelling device.

2. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with the upper portions or air-spaces of said tanks, a valve controlling said conduit, a circulation conduit likewise connected with the air-spaces of the tanks and by-passing said valve, and a fluid-propelling device included in said circulation conduit.

3. A stabilizing device for ships, comprising oppositely located tanks adapted to contain a liquid, a conduit connecting the upper or air spaces of said tanks, a valve in said conduit, a circulation conduit connected with the first-named conduit and by-passing said valve, a fluid-propelling device connected with said circulation conduit, and means for controlling said propelling device.

4. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a valve controlling said conduit, a circulation conduit connected with the first named conduit and by-passing said valve, a fluid propelling device connected with said circulation conduit, means for controlling said propelling device, and means for setting said valve and said controlling means in response to the ship movements which it is desired to damp.

5. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a valve controlling said conduit, a circulation conduit connected with the first named conduit and by-passing said valve, a fluid propelling device connected with said circulation conduit, means for controlling said propelling device, and hydraulic mechanism for setting said valve and said controlling means in response to the ship movements which it is desired to damp.

6. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a valve controlling said conduit, a circulation conduit connected with the first named conduit and by-passing said valve, a fluid propelling device connected with said circulation conduit, means for controlling said propelling device, and hydraulic mechanism for setting said valve, said mechanism consisting of two hydraulic setting cylinders and a slide valve controlling said cylinders in response to the ship movements which it is desired to damp.

7. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a valve controlling said conduit, a circulation conduit connected with the first named conduit and by-passing said valve, a fluid propelling device connected with said circulation conduit, means for controlling said propelling device, and hydraulic mechanism for setting said valve, said mechanism consisting of two hydraulic setting cylinders, a slide valve controlling said cylinders, electromagnetic coils for setting said valve, a shaft indicating the reversal of the ship's oscillating motion, and means, actuated by said shaft, for controlling the energizing of said coils.

8. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a circulation conduit connected with said tanks, a fluid-propelling device connected with said conduit, means for controlling said fluid-propelling device, a pressure-equalizing conduit connected in parallel with the first-named conduit, a shut-off valve in said pressure-equalizing conduit, an arm connected to move in unison with said valve, hydraulic cylinders for controlling said arm in such a way as to block its movement in one direction at all times, a slide valve controlling the supply of liquid to said cylinders, a control shaft, and two electromagnetic coils actuated by said shaft and adapted to set said slide valve in response to the ship movements which it is desired to damp.

9. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a shut-off valve in said conduit, a circulation conduit arranged in parallel with the first-named conduit, a fluid-propelling device connected with said circulation conduit, a regulating device for said fluid-propelling device, a hydraulic slide valve for setting said regulating device, and another slide valve controlling said hydraulic slide valve in response to the ship movements which it is desired to damp.

10. A stabilizing device for ships, comprising tanks adapted to contain a liquid and located on the port and starboard sides respectively, a conduit connecting the upper or air spaces of said tanks, a shut-off valve in said conduit, a circulation conduit connected with said tanks, a fluid-propelling device associated with said circulation conduit, a regulating device for said fluid-propelling device, hydraulic cylinders for controlling said valve and said regulating device, a slide valve controlling said cylinders, electromagnetic coils for setting said slide valve, a shaft for actuating said coils in response to oscillations of the ship, and means for throwing the fluid-propelling device out of action whenever the fluid level in the tanks reaches it maximum or minimum.

11. A stabilizing device for ships, comprising tanks adapted to contain a liquid and located on the port and starboard sides respectively, a conduit connecting the upper or air spaces of said tanks, a shut-off valve in said conduit, a circulation conduit connected with said tanks, a fluid-propelling device associated with said circulation conduit, a regulating device for said fluid-propelling device, hydraulic cylinders for controlling said valve and said regulating device, a slide valve controlling said cylinders, electromagnetic coils for setting said slide valve, in response to the ship movements which it is desired to damp, conduits connecting said slide valve with said hydraulic cylinders, shut-off valves in said conduits, electromagnetic coils for setting said shut-off valves, floats located in the upper and in the lower portions of the tanks, and means, controlled by the movement of said floats, for energizing said coils.

12. A stabilizing device for ships, comprising tanks adapted to contain a liquid and located on the port and starboard sides respectively, a conduit connecting the upper or air spaces of said tanks, a shut-off valve in said conduit, a circulation conduit connected with said tanks, a fluid-propelling device associated with said circulation conduit, a regulating device for said fluid-propelling device, hydraulic cylinders for controlling said valve and said regulating device, a slide valve controlling said cylinders, electromagnetic coils for setting said slide valve in response to the ship movements which it is desired to damp, conduits connecting said slide valve with said hydraulic cylinders, two-way cocks controlling said connecting conduits, an electromagnetic coil for actuating said cocks, means for energizing said coil whenever the liquid level in said tanks reaches its maximum or minimum, to throw said slide valve into its inactive position, another slide valve, conduits connecting said second slide valve with said hydraulic cylinders, and controlled by said two-way cocks to establish such connection whenever the first-mentioned slide valve is brought to its inoperative position, and thereby to bring the regulating device of the fluid-propelling device back to its zero position, and a mechanical connection between said regulating device and said second-mentioned slide valve.

13. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a valve controlling said conduit, a circulation conduit connected with the first named conduit and by-passing said valve, a fluid propelling device connected with said circulation conduit, a regulating device for said fluid-propelling device, hydraulic piston valves for setting said controlling valve and said regulating device respectively, a common slide valve controlling said hydraulic piston valves, electromagnetic coils controlling said slide valve, a shaft controlling the energizing of said coils, and integrators, damped to different degrees, movable in response to the ship movements which it is desired to damp, and operatively connected with said shaft.

14. A stabilizing device for ships, comprising tanks adapted to contain a liquid, a pressure-equalizing conduit connected with said tanks, a valve controlling said conduit, a circulation conduit connected with the first named conduit and by-passing said valve, a fluid propelling device connected with said circulation conduit, a regulating device for said fluid-propelling device, means for setting said valve and said regulating device, a control shaft co-operating with said setting means, and two integrators for setting said shaft to different positions, said integrators being actuated according to the extent of the ship oscillations which it is desired to damp.

15. A device according to claim 14, in which the two integrators are damped hydraulically to different degrees.

16. A device according to claim 14, in which the two integrators are connected in parallel and damped hydraulically to different degrees.

17. A stabilizing device for ships, comprising tanks adapted to contain a liquid and located at the port and starboard sides of the ship respectively, a pressure-equalizing conduit connected with said tanks, a shut-off

valve in said conduit, a circulation conduit likewise connected with the said tanks, a continuously operating fluid-propelling device, and a two-way cock the position of which varies in response to the oscillations of the ship, said cock, according to its position, connecting the circulation conduit in one way or the reverse way, with the suction and delivery ports of said fluid-propelling device.

In testimony whereof I affix my signature.

HERMANN HORT.