STABILIZATION OF FLOATING BODIES

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5 Claims. (Cl. 114—125)

This application is a continuation-in-part of my application No. 306,541, filed September 4, 1963, now abandoned.

The invention relates to stabilizing means for floating bodies to prevent or, at least, reduce the pitching and/or rolling motion in disturbed water.

The invention consists in a vessel provided with liquid ballast contained in tanks located at the sides, means for continuously transferring ballast at the same general level both through each of the side tanks and around circulating paths outside the tanks in such a way that the communications through each tank are at least interconnecting and means for controlling the transfer of ballast in order to reduce the level of liquid stored in any one tank and increase it in the other for the purpose of setting up a couple which opposes the couple acting on the vessel.

Embodyments of the invention will be described with reference to the drawings in which:

FIGURE 1 is a plan view of a stabilizer according to the invention;

FIGURE 2 is a cross section thereof on the line II—II of FIGURE 1;

FIGURE 3 is a plan view of a modification of FIGURE 1 in the inoperative condition;

FIGURE 4 is a section of this on the line IV—IV of FIGURE 3; and

FIGURE 5 is a similar view to FIGURE 3 but shown in the operative condition.

In the drawings, in which like numerals refer to like parts, tanks 1 and 2 are disposed at the sides of a vessel 3 and rest on the bottom platting 4. The bottom portions of the tanks are connected at their forward ends by duct 5 and at their after ends by duct 6. The ducts 5 and 6 lie wholly between two vertically spaced horizontal planes with the lower plane at substantially the same level as the bottom of the tanks 1 and 2 and with the upper plane at a level below the mid-height of the tanks 1 and 2. A cross duct 7 joining ducts 5 and 6 is provided with an impeller 8 driven by an electric motor 9 through shaft 10. Duct 5 is provided with valve means 11 and 12 to control the flow of water into and out of tanks 1 and 2 respectively and duct 6 has valve means 13 and 14 similarly disposed therein. In the particular embodiment shown the valve means are actuated by solenoids 15 over links 16. In large installations more powerful actuating means for example, an electro hydraulic relay would be required. Conveniently, the valve actuating means may be differently operated by a roll sensing means of known kind as shown in U.S. Patent No. 3,045,630.

The tanks are filled with liquid ballast, for example water, at least to a height which ensures that with the vessel on an even keel the system of ducts and the pumping means are filled.

Thus, when the vessel is not subjected to a rolling couple the valves 11 to 14 are open and water continuously circulates through the tanks 1 and 2 as indicated by the arrows (FIGURE 1). When, however, the sensing means detect a rolling couple, for example a couple tending to roll the ship to port, valves 11 and 14 are closed so that the water is pumped from tank 1 through open valve 13 into tank 2 through open valve 12 thereby to produce an anti-rolling couple (FIGURE 2).

So that the tanks may be completely emptied, the ducts 5 and 6 are continued into the tanks 1 and 2 and turned downwardly as at 21 to face a depression or sump 17 formed in the floor of the tank. The floor is then continued to the side of the tank opposite the duct in a slightly upward direction (FIGURE 3). The tops of tanks 1 and 2 are interconnected by a pipe or air duct 18. The air duct enters the tank at the side at a short distance from the top so that an air cushion 19 is provided between the water surfaces. The top of the tank when said tank is full. The air duct is upwardly curved in its centre section to retard the free flow of water from the full tank to the empty one. A further air duct or pipe 20 connects water duct 7 with the air duct 18 to take away entrained air in the water duct and thus ensure that the impeller 8 always operates in a "solid" mass of water.

A relief valve 22 is included in air duct 18 to allow for expansion and contraction of air within the tanks due to changes in ambient temperature.

For operating the system there is provided sensing means 23 which is responsive to the various functions of the rolling motion of the ship. The drawings show a sensing means responsive to roll angle φ, roll velocity ω and roll acceleration α. Electrical signals derived therefrom are combined in any desired ratio and fed to the solenoids 15 over lines 24 to provide differential opening and closing of valves 11, 12, 13 and 14 in proportional response to the control signal. Sensing means of the kind described are well known in the art.

FIGURES 3, 4 and 5 illustrate in schematic form the arrangement of FIGURES 1 and 2 but with a further modification. For clarity of illustration, the illustration of the valves in the figures is not entirely consistent.

FIGURES 3 and 4 show the conditions prevailing when the ship is not rolling. The valves 10, 11, 12 and 13 are partially open and the pumping means maintains the circulation of water in the directions generally indicated by the arrows.

FIGURE 5 shows the conditions prevailing when the ship experiences an acceleration inducing the ship to roll to port. The acceleration sensing means 23 has caused valves 11 and 14 to close and valves 12 and 13 to open. The pumping means 8 will now induce a strong flow of water out of tank 1 and into tank 2 as shown by the arrows thereby to induce a force in the ship which will oppose the applied acceleration. To further improve the response to acceleration forces an additional tank 24 is provided elevated from duct 5 and communicating therewith via ducts 25. When the stabilizing means is in the quiescent state as shown in FIGURE 3, in which valves 11 and 12 are only partially open, the pumping means will induce a partial hydrostatic head in duct 5 which will force water up into tank 24. When, in response to an imposed acceleration, say to port as in the figure, valve 11 closes and valve 12 opens widely, the hydrostatic head falls sensibly to zero and water in tank 24 descends rapidly into duct 5 to be added to the flow into tank 2. It will be seen that the storing of water in tank 24 for rapid release when required constitutes, in effect, a smoothing device for the pumping means. It will also be appreciated that the valves will operate in the opposite sense for an acceleration to starboard.

The present construction may be operated as a passive stabilizer by shutting off the pumping means and the valve actuating means and setting the valve means to provide the required angle of lag for the flow of water through the duct or ducts.

In further variations the action of the passive and activated systems can be combined in various proportions.

Various modifications may be made within the scope of the invention.
I claim:

1. An arrangement for the stabilization of a ship comprising two tanks located one on either side of the ship, two passages each interconnecting the bottom portions of the two tanks, said passages lying wholly between two vertically spaced horizontal planes with the lower plane at substantially the same level as the bottoms of said tanks and with the upper plane at a level below the mid-height of said tanks, a third passage interconnecting the said two passages, pumping means for passing liquid through the third passage, flow control means controlling communication between the tanks and the said passages and operable to allow circulation of the liquid through both tanks and the passages or to accumulate the liquid in either of the tanks while drawing it from the other.

2. An arrangement as claimed in claim 1 further comprising a third tank located centrally of the ship and communicating with one of the said two passages downstream of the pumping means whereby liquid may be stored in the third tank when the hydrostatic head in said one passage is elevated by restricted flow conditions to allow more rapid filling of either of the said two tanks upon full opening of the flow control means to allow flow therewith.

3. An arrangement for the stabilization of ships comprising tanks on each side of the ship, at least two passage means respectively interconnecting and at the same level as the bottoms of the tanks, pump means for transferring liquid through said tanks and around said passage means, a sump at the bottom of each tank at the point where a passage means enters, said passage means continuing inward of the tank and turning downwards so that its orifice is over the sump at a level corresponding to the base of the tank and valve means in said passage means for controlling the liquid transfer to effect the accumulation of liquid in the tank at any one side of the ship and draining of liquid from the tank at the other side of the ship.

4. An arrangement as claimed in claim 3 in which the floor of the tank slopes upwardly away from the sump.

5. An arrangement as claimed in claim 3 in which the area of clearance between the orifice of the passage means and the perimeter of the sump is at least equal to the cross sectional area of the passage means.

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