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VESSEL STABILIZATION SYSTEM

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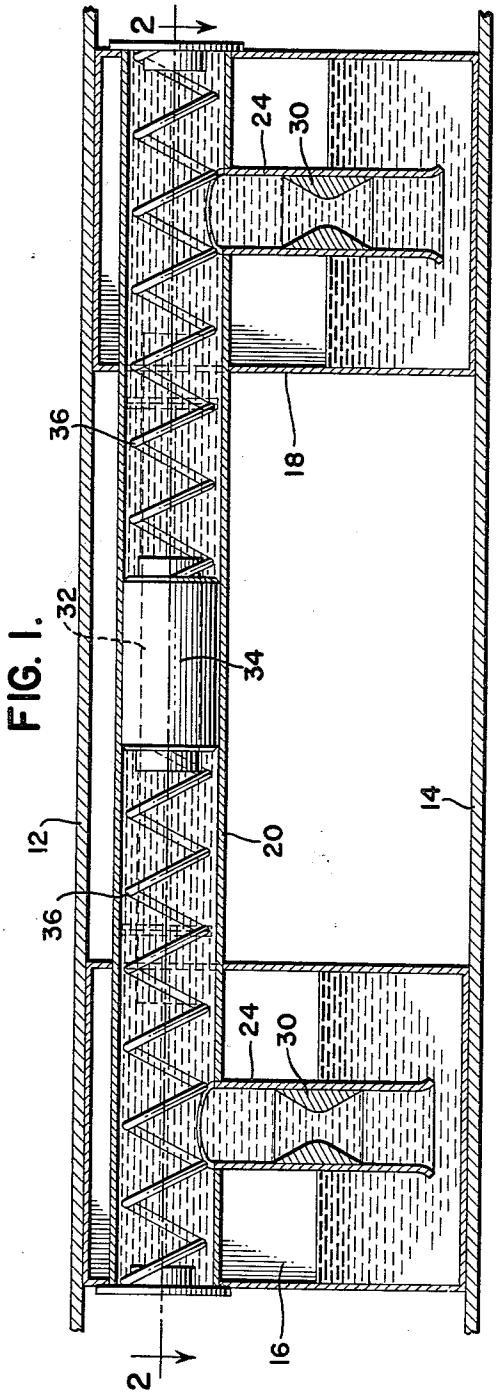


FIG. 1.

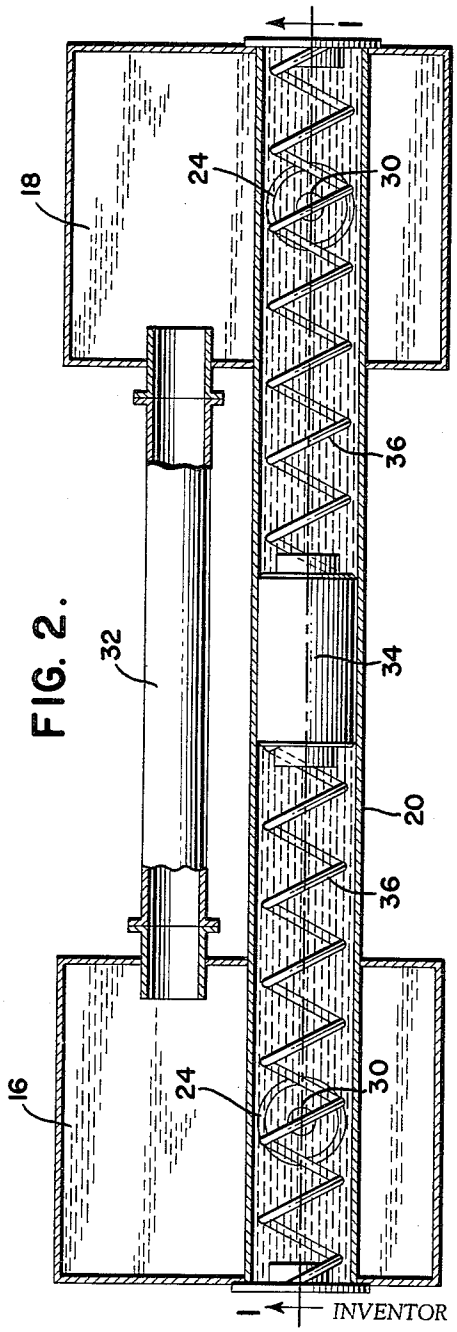


FIG. 2.

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VESSEL STABILIZATION SYSTEM

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The present invention relates to vessel stabilization systems and, more particularly, to a vessel stabilization system of the type wherein passive anti-rolling compartments or tanks are utilized.

The need for stabilizing a vessel against wave action is recognized by the art. Many forms of apparatus have been proposed for this purpose. Essentially, the apparatus advanced to offset the action of wave motion or its effect, rolling, and this term is to be construed hereinafter as including pitching action also, have taken essentially two principal forms. In one form, the apparatus is characterized by an energy input into the stabilizing system, and for this reason these various systems have been categorically grouped as activated systems. The two main activated systems are the activated fin stabilization system and the so-called Minorsky system. In the former system, fins project laterally from the vessel in a plane below the water line. Due to the stabilizing requirements, the fins are quite large and heavy machinery is required to effect the necessary extension, retraction, and activation of the fins. Consequently, there is a large energy demand for the operation of the system, and the system is expensive to manufacture. In the Minorsky type of activated system, it was intended that a pair of tanks be provided and the fluid housed in the tanks be pumped between them rhythmically 90° out of phase leading the rolling angle of the vessel. When the fluid transfer leads the roll angle by 90°, a pure damping moment is produced. The Minorsky system is not being actively pursued today because of the difficulties inherent in the problems of control.

The other main category of stabilization systems is passive stabilization arrangements. The only substantial advancement known in the prior art in this particular area is the contributions that were made by Frahm just prior to World War I and shortly thereafter. In the Frahm system, a pair of tanks were located on opposite sides of a vessel and a U tube crossover duct interconnected the bottom portions of the tanks. An air crossover duct interconnected the top portions of the tanks. A valve or similar throttling mechanism was located in the air crossover duct for the purpose of throttling or damping during the passive exchange of fluid from one tank to the other as a result of the motion of the vessel. The Frahm type stabilization system was incorporated in a substantial number of vessels, but was ultimately abandoned because the system was objectionably noisy due to sonic effects in the air crossover duct; the system produced destabilizing effects when excited at frequencies removed from the resonant frequency of the system; the weight and space requirements were considered excessive, and the system could not practically be designed to a one deck height.

The desirability of a passive stabilization system in preference to an activated stabilization system has long been recognized by the art. A passive system does not require input of energy and there are, accordingly, no activated moving parts, as such, which require care or lubrication. Further, passive systems can be designed at a substantially lower cost and also are easier to install.

Accordingly, it is the principal object of the present invention to provide a highly unique and original design for a passive stabilization system for vessels which overcomes all of the disadvantages and drawbacks of prior

known passive stabilization systems and which is capable of performing stabilization effectively, efficiently and expeditiously in any and all size vessels.

This is accomplished by the present invention by providing a liquid transfer arrangement athwart a vessel which includes a means for dissipating energy during liquid transfer characterized by a non-linear operation. In a specific preferred embodiment of the present invention, a pair of tanks are located athwart the vessel and are interconnected by a transfer duct whereby liquid housed within the tanks will flow from one to the other through the transfer duct in response to rolling of the vessel. The transfer duct is uniquely designed to terminate at either end in a nozzle to introduce velocity squared damping during liquid transfer. It is considered important in the design of the present invention that the air or other gas present over the liquid contained in each of the tanks not exert any influence upon the operation of the system. Accordingly, provision is made for the instantaneous equalization of the pressure above the liquid contained in the tanks. This can be done in a number of ways. For example, the tanks may be vented to the atmosphere if the liquid contained above them be air or the tanks may be interconnected by air pipes so that the spaces above the liquid are in complete and effective communication.

As a further refinement to the present invention, provision is made for reducing the bulk of the liquid required to be contained in the two tanks by the provision of a dense mass located within the liquid crossover duct. It is recognized by the present invention that a portion of the liquid present in the crossover duct will not leave the crossover duct during operation of the system. Under these circumstances, a slug of liquid is removed from the crossover duct and the space which it occupied is taken up by a slug of solid material having a density substantially greater than that of the liquid. Resilient biasing means are provided acting against opposite ends of the dense slug in order to restore it to a repose position at the conclusion of the operation of the passive system. The resilient means will also act during the operation of the passive system to assist in the back and forward movement of the dense slug.

It is a further object of the present invention to provide a novel passive stabilization system which operates efficiently and effectively to offset the rolling effects produced by natural wave action.

Other objects and advantages of the present invention will become readily apparent from the following detailed description of a specific embodiment of the present invention when taken in conjunction with the appended drawings in which:

FIGURE 1 is a view in vertical section of a preferred embodiment of the present invention taken along line 1—1 of FIGURE 2; and

FIGURE 2 is a view in section taken along line 2—2 of FIGURE 1.

Referring now to the drawings in particular, adjacent decks of a vessel are designated by the reference numerals 12 and 14 and may be considered to be representative of the deck structure of any one of a number of typical oceangoing vessels. In the design of oceangoing vessels, one deck height is normally considered to be approximately 9½ feet. The apparatus of the present invention, as illustrasted in the drawings, is portrayed to reside between the pair of decks 12 and 14. The apparatus consists of a pair of tanks 16 and 18 located athwart the decks 12 and 14. Each of the tanks contains liquid, e.g. water or oil, to the level as indicated. A liquid crossover duct 20 passes from one tank to the other and terminates within each tank in a T section. The crossbar of the T is comprised of the end portions of the

liquid crossover duct and the vertical leg of each T is comprised of the short duct sections **24**. Each short duct section **24** includes within it a conventional nozzle design designated by the reference numeral **30**. Contained within the liquid crossover duct is a plunger **34** composed of very dense material, such as lead or steel. A pair of springs **36** co-operate with the plunger and bear against the end walls of the liquid crossover duct. An air pipe **32** communicates the spaces above the liquid level in the tanks. As mentioned previously, the air space above the liquid in each of the tanks may be vented to atmosphere. The important consideration here is that the pressure within the two tanks be substantially equal at all times.

In the operation of the present invention, as the vessel rolls from side to side, the liquid in the two tanks will be displaced and the plunger in the liquid crossover duct will move relative thereto. The nozzles **30** in the short vertical duct sections **24** will operate to dissipate energy from the moving liquid non-linearly by velocity squared damping.

In the design of the present invention, it is possible and practical to design the apparatus such that the movement of the plunger in the liquid crossover duct for the worst condition to be encountered can be confined so that it will not strike the ends of the crossover duct. Under all other conditions, the system will operate effectively for stabilization.

The outstanding feature of this system is that as the stabilized roll of the ship decreases the effectiveness of the stabilizer increases. The reduction of roll, expressed as percent, is greater for smaller angles of roll, and, accordingly, this system is inherently ideally suited to practical applications which require that it operate in seas of moderate severity (state 5 sea or less) which are encountered most of the time. The system also operates very satisfactorily, however, in extreme seas (state 6 and above), which are rare. This is summarized by the statement that these stabilizers are normally designed around an average stabilized roll of about 2 degrees from the vertical, and for this type of operation, which relates to about a state 5 sea, the percent reduction of roll is impressive enough to warrant widespread recognition from the naval architects.

Although the present invention has been shown and

described in terms of a single specific preferred embodiment, it will be appreciated that changes and modifications will occur to those skilled in the art from a knowledge of the teachings of the present invention. Such changes and modifications as are obvious are deemed to come within the purview of the present invention.

What is claimed is:

1. The combination of a vessel and a stabilization system therefor comprising, a pair of wing tanks mounted in spaced relation of opposite sides of the vessel centerline, crossover duct means interconnecting said wing tanks, said duct means defining restricted communicating openings adjacent each interconnection with a wing tank to produce a substantial jet loss of head from liquid passing therethrough, an unobstructed air equalization duct interconnecting the upper portion of said wing tanks, liquid in said wing tanks and said duct at a level in repose spaced substantially below the top of said wing tanks and filling said duct means completely, weight means positioned in said duct means, and means biasing said weight means to a mid-position in said duct means.

2. The combination of claim 1 wherein said duct means project into said wing tanks and include vertical portions that terminate adjacent the bottom of said wing tanks.

3. The combination of claim 1 wherein said means biasing said weight means is comprised of a pair of springs.

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