Nov. 15, 1966 S. B. FIELD ET AL 3,285,216

PITCH STABILIZATION SYSTEM FOR WATER GOING VESSELS

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Fig. 1.

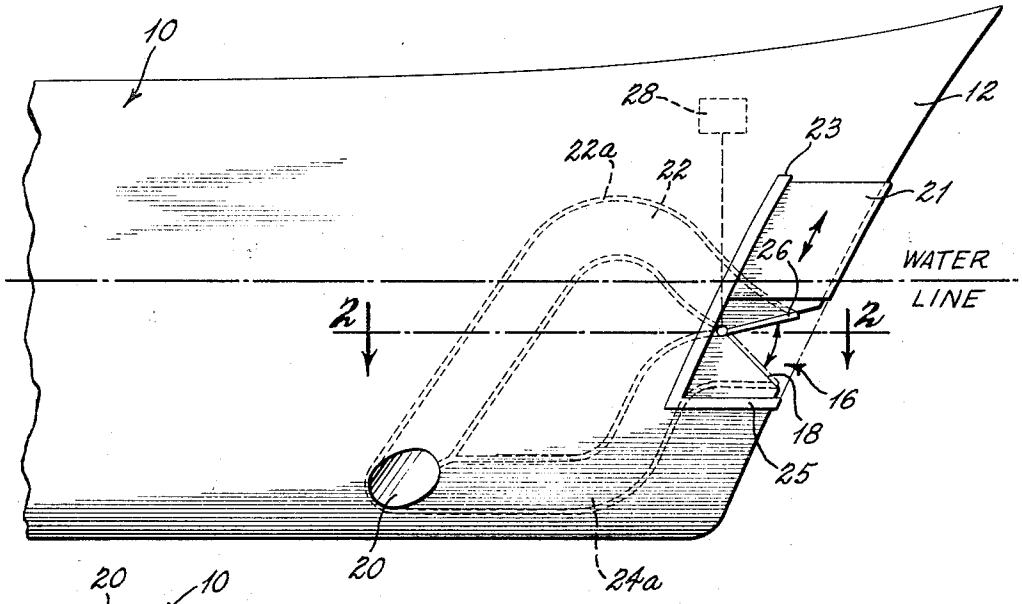
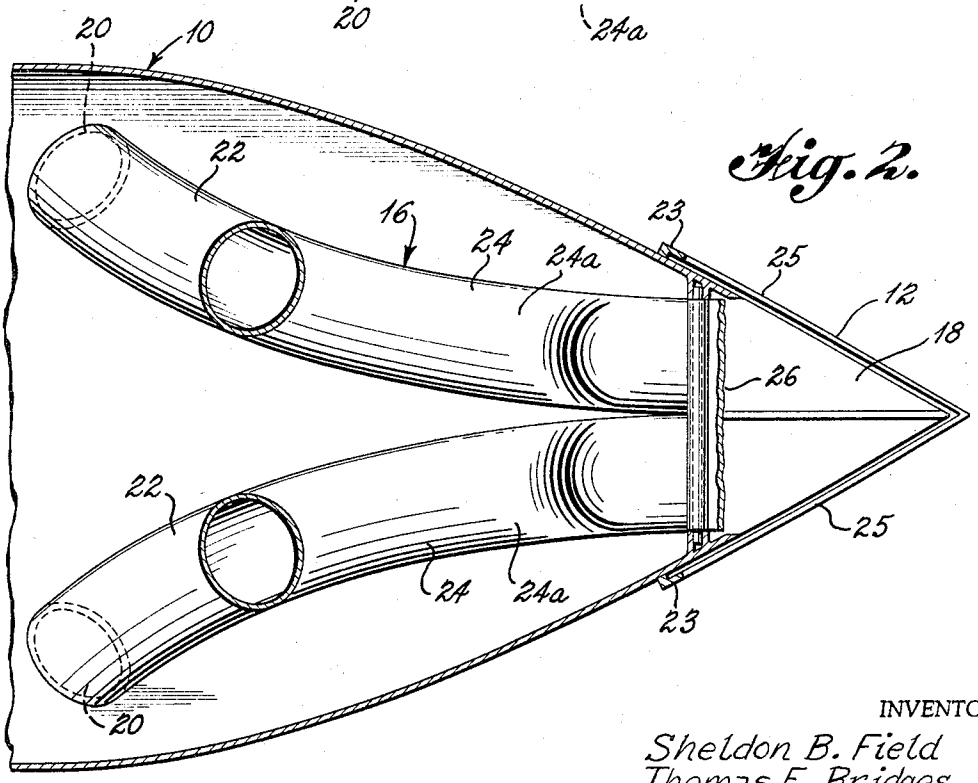


Fig. 2.



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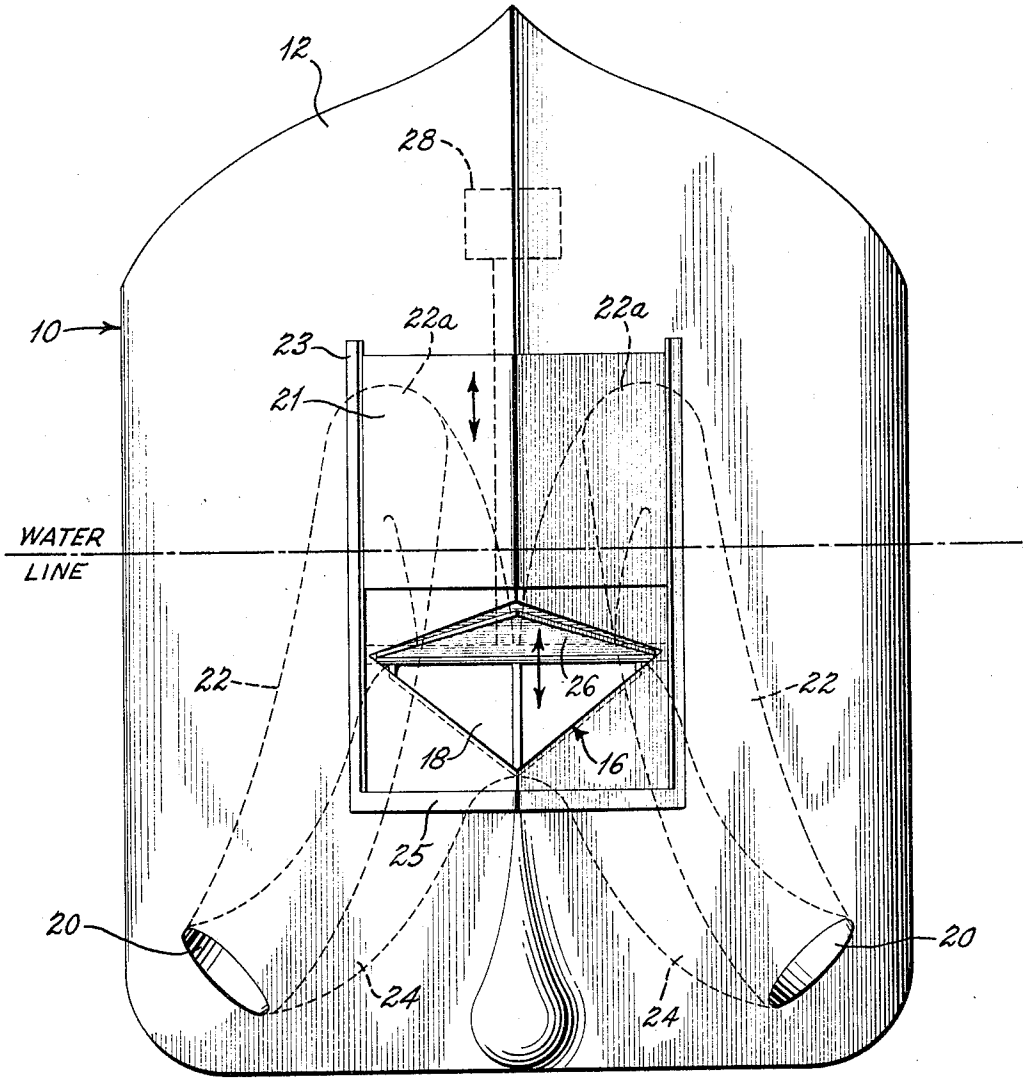
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PITCH STABILIZATION SYSTEM FOR WATER GOING VESSELS

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Fig. 3.



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PITCH STABILIZATION SYSTEM FOR WATER GOING VESSELS

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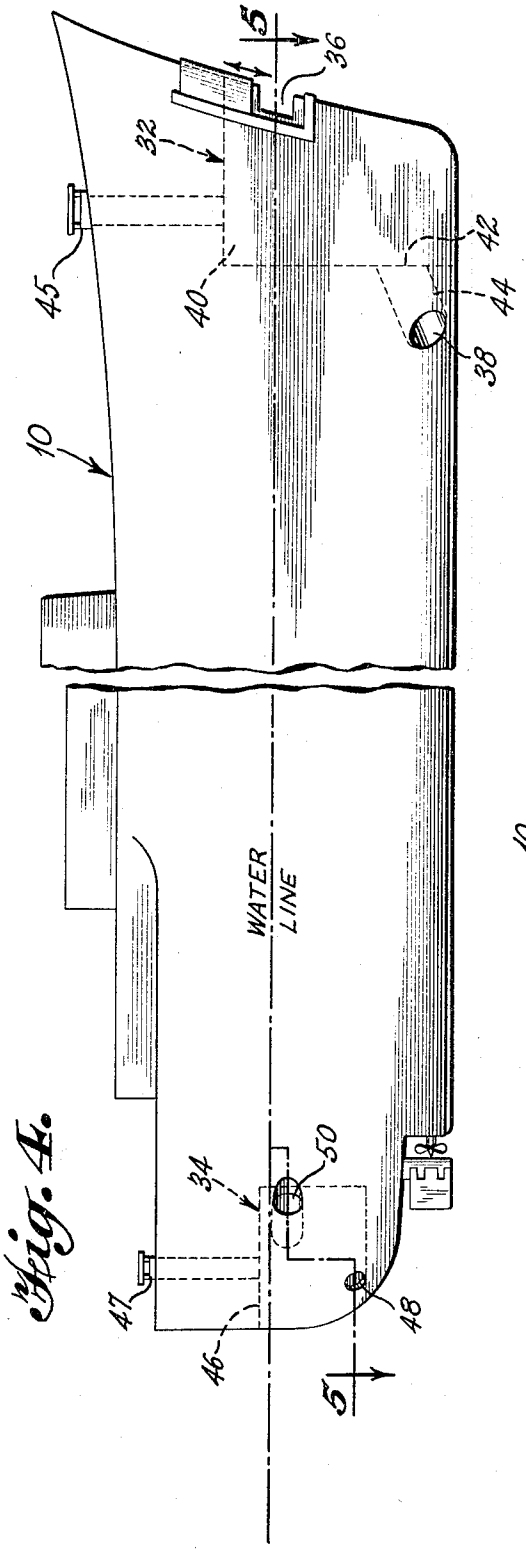


Fig. 4.

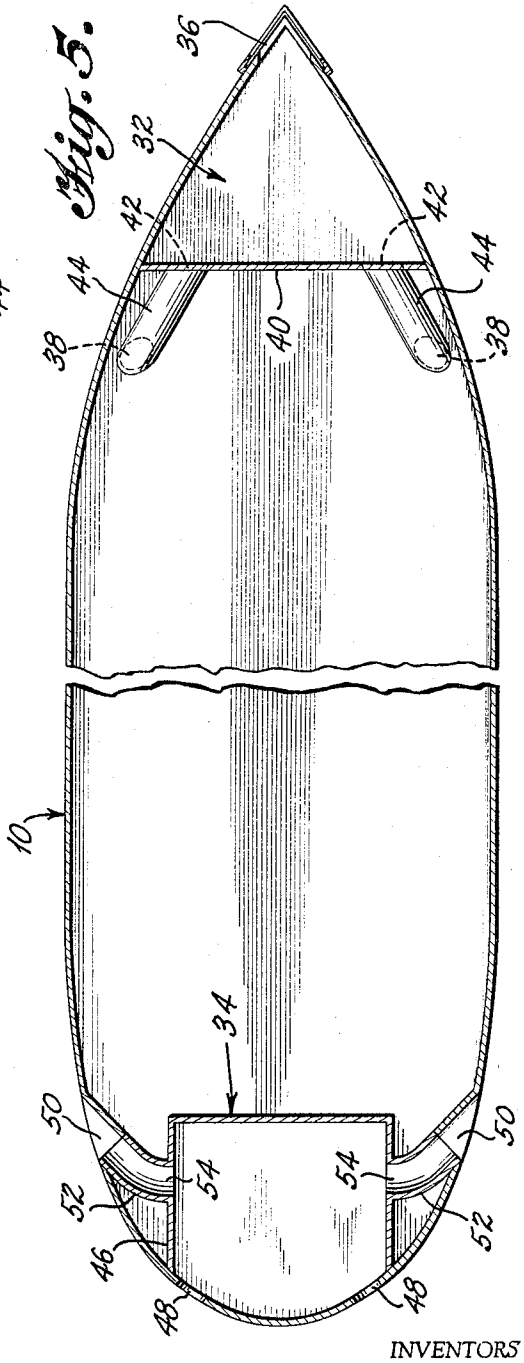


Fig. 5.

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PITCH STABILIZATION SYSTEM FOR WATER GOING VESSELS

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This invention relates to a system for stabilizing a water going vessel in the pitch plane and more particularly a pitch stabilization system which controls a flow of liquid through portions of the ship for the purpose of imparting pitch stabilizing forces to the ship.

With the increased ocean and water travel, both pleasure and merchant, there has arisen a great need for ship stabilization in the pitching plane of the vessel. In the case of pleasure cruises, pitch stabilization is desirable to make the ocean voyage more pleasant and attractive to the passengers for the purpose of improving their comfort and well-being. Pitch stabilization is important for merchant vessels so that ship speed need not be varied and other measures taken during voyage to avoid extreme pitching. Furthermore, great pitching may result in injury or loss to cargo.

Great strides have been made in the roll stabilization art using passive stabilizers, and these stabilizers are generally characterized by an elongated container and a body of fluid therein moving from one side of the container to the other in response to the roll of the ship, so that a stabilizing moment is imparted to the ship in opposition to the roll thereof. See, for example, U.S. Patent No. 3,054,373, U.S. Patent No. 3,083,672, and U.S. Patent No. 3,083,674.

However, the problems encountered in stabilizing the vessel in the pitching plane are greatly different from those of stabilizing the vessel in the roll plane. Due to the large longitudinal metacentric height of the vessel and the large exciting pitching moment imparted by the waves to the vessel, it would be impractical, if not impossible, to have a movement of fluid through the longitudinal axis of the ship which imparted any significant stabilizing moment to the ship in the pitching plane. This impracticality is enhanced by the fact that the period of pitching is relatively short in relation to the length of the vessel, so that there would have to be great volumes of liquid moved through great distances within the ship to impart any appreciable pitch stabilizing moment to the ship. Furthermore, any ducting or channel means located throughout the longitudinal dimension of the vessel would take far too much space from the designed cargo handling capabilities of the vessel.

Another problem encountered in pitch stabilizing a vessel stems from the generally accepted fact that the vessel will reach its most extreme value when the period encountered by the waves in equal to the natural period of pitching of the vessel and when the length of the wave is the same as the length of the ship.

The present invention solves the above problems without the disadvantage of having great channels or ducting networks existing throughout the vessel. Stated briefly, the present invention incorporates channels or tanks located at the bow and/or stern of the vessel and enables water to enter and leave the bow and/or stern in a controlled manner such that the weight of the water or the movement of the water through and bow and/or stern portion of the vessel will impart stabilizing forces at the bow and stern of the vessel. It can be understood that these forces imparted at the bow and/or stern of the vessel take advantage of the long pitching stabilization moment arm for the vessel.

Therefore, it is an object of the present invention to provide a stabilization system which stabilizes the ship in the pitching plane.

It is another object of the present invention to provide a pitching stabilization system which imparts forces at the bow of the ship in response to the upward or downward movement of the bow, said forces opposing the upward or downward movement of the bow.

It is another object of the present invention to provide a pitch stabilization system comprising two subsystems, one at the bow and one at the stern of the ship.

Other and further objects of the present invention will become apparent with the following detailed description when taken in view of the appended drawings in which:

FIG. 1 is a side elevation of the vessel showing the stabilization system in the bow thereof;

FIG. 2 is an exploded top plan view taken in section along line 2—2 of FIG. 1;

FIG. 3 is a front elevation showing the disposition of the bow stabilization system;

FIG. 4 is a side elevation of another embodiment of the invention; and

FIG. 5 is a top plan view taken in section along line 5—5 of FIG. 4.

Referring to FIGS. 1–3 in detail, there is shown a ship generally indicated as **10** having a bow section **12**. Mounted in the bow section **12** is the pitch stabilization system **16** having an inlet port **18** at or near the extreme front end of the ship and a pair of outlet ports **20** mounted on either side of the vessel. A pair of overhead pipes **22** communicate with the inlet port **18** and outlet ports **20** and define a tortuous path and have an elbow **22***a* which is substantially higher than the inlet port **18**. In a like manner, another pair of pipes **24** located below the overhead pipes **22** also communicate with inlet port **18** and outlet ports **20**. Pipes **24** also define a tortuous path and have an elbow **24***a* which is substantially lower than inlet port **18**. A flapper or valve **26** is hinged in the region of the inlet port **18** for selectively opening and closing the respective paths for pipes **22** and pipes **24**. Conventional manual or automatic operating means **28** is mechanically linked to valve flapper **26** to control the opening and closing of the respective paths in response to the pitching of the ship.

A sliding valve or V-shaped plate **21** is slidably secured to the front part of bow **12** by guide members **23**. The valve plate **21** is secured in its upper position by conventional latching means (not shown) when the pitch stabilization system is in use. When it is desired not to use the pitch stabilization system, the valve plate **21** is placed in its lowermost position and secured thereto by horizontal limiting guides **25**. With the valve plate **21** in its closed position, that is the lowermost position, the pitch stabilization system does not function and the hydrodynamic design of the bow section is not diminished.

The operation of the system disclosed in FIGS. 1–3 will now be described. It can be seen that inlet port **18** is located well below the water line as the vessel rides in the sea. As ship **10** is propelled forward, there is a great rush of water in throught port **18**, through one of the sets of pipes **22** or **24**, and out through the port **20**. When ship **10** is in a pitching condition and the bow of the ship is substantially above the stern so that the bow will begin moving downward and the stern upward about the pitching axis, control means **28** will force valve **26** to the lower position (FIG. 1) so that great volumes of water rush through inlet port **18** up through the overhead pipes **22** and out through ports **20**. As the great

volumes of water flow around the elbows 22*a*, the kinetic energy thereof imparts an upward force to the bow of the ship in opposition to the downward motion of the bow of the ship so that stabilization is imparted thereto with substantially the maximum moment arm possible. When the bow of the ship is in its lowermost position and starts to rise, control means 28 throws valve 26 to its upper position so that great volumes of water rush through port 18 into the lower pipes 24 and outlet ports 20. As the direction of this great volume of moving fluid is changed due to elbow 24*a*, a downward force is imparted to the bow of the ship in opposition to the rising thereof. In this way, it can be seen that pitching stabilization forces are imparted to the bow of the ship in opposition to the pitch motion thereof.

When calm seas are encountered and the pitch stabilization system is not to be used, V-shaped valve plate 21 is lowered to close off the inlet port 18.

It is pointed out that the ship need not be under way for the system to function. The upward and downward movement of the bow is sufficient to cause water to pass through port 18, pipes 22 and 24, and ports 20. However, the system will operate more efficiently when the vessel is moving forward.

Referring now to the embodiment shown in FIG. 4 of the drawings, there is illustrated a pitch stabilization system for ship 10 which comprises two subsystems, that is the bow subsystem 32 and the stern subsystem 34. The bow subsystem comprises a valve inlet port 36 which is normally open when the subsystem is in operation and a pair of outlet ports 38 mounted on the bottom and opposite sides of the vessel. Inlet opening 36 communicates with an enlarged tank 40, said tank 40 having a pair of openings 42 located at the substantially bottom end of said tank 40. A pair of pipes 44 are disposed in free communication with tank outlet 42 and outlet ports 38. The incorporation of pipes 44 is the preferred embodiment; however, if desired, the outlet ports 38 can be disposed in the common wall of the bow of the ship and tank 32. This arrangement would avoid the necessity of using connecting pipes 44.

The top of tank 40 is open to the atmosphere or communicates with the atmosphere by the use of any known means such as piping or venting 45. It will be noted that inlet port 36 is located substantially at the water line of the vessel, and that tank outlet 42 and outlet port 38 are located substantially below the water line.

The stern subsystem 34 comprises a similar tank 46 and a pair of outlet ports 48 which provide communication between tank 46 and the ambient. The midsection of tank 46 is preferably disposed below the water line similar to tank 32. Port 48 is normally valved open when the system is in operation. A pair of inlet ports 50 defined on either side of the ship communicate with tank 46 via a pair of pipes 52 and tank inlets 54. It can be seen that the inlet ports 50 are located substantially at the water line of the vessel and the outlet port 48 is located substantially near the bottom of tank 46. Tank 46 is venter to the atmosphere through pipe 47.

The operation of the system in FIG. 4 will now be described. Let it be assumed that the vessel 10 is moving in a forward direction and is encountering the normal degree and frequency of pitching. As the bow noses deeper into the water and the stern rises, there will be a substantial amount of liquid flowing through the inlet port 36 into tank 40 and since the flow of liquid into tank 40 is greater than the flow of liquid out of tank 40 through outlet ports 38, there will be a net increase in the amount of liquid within tank 40. Therefore, as the bow reaches its lowermost position and begins to rise, there will be a greater weight of liquid within tank 40, thus opposing the rising of the bow of the ship 10. As the vessel passes through a horizontal position, inlet port 36 will rise above the water line so that water no longer flows into tank 40. As the bow of the ship continues to rise, the level of liquid within the tank 40 is substantially above the water line so that there is an increased potential pressure head given to the liquid within tank 40, and consequently, a great amount of liquid will pass through pipes 44 and outlet ports 38. Therefore, the weight in the bow of the ship is reduced as the bow of the ship rises to its maximum height so that the lowering of the bow is not aided by increased weight therein. As the bow again noses down past the water line, there is increased buoyancy in tank 40 due to the lower liquid level in said tank. Said increased buoyancy exists but is continually decreased as water rushes through inlet port 36 to again fill the tank 32. The water rushing through inlet port 36 during this portion of the pitching cycle fills tank 32 to the height which opposes the rising of the bow as aforementioned. In this way, the pitch stabilization forces are imparted to the bow of the ship with the substantially maximum pitching moment arm.

The stern pitch stabilization subsystem operates in a similar manner, that is when the stern of the ship is below horizontal, the inlet ports 50 are below the water line so that tank 46 takes on a great volume of water and the level of liquid therein rises. As the stern of the ship begins to rise, the greater weight of water in tank 46 opposes said rising of the stern and imparts a downward force thereto. As the stern of the ship passes through the horizontal position and continues to rise, tank 46 ceases to take water because the inlet ports 50 are above the water line. At this time, the increased level of water within tank 46 is given a greater potential pressure head so that outward flow of water through outlet port 48 continues at a greater rate so that the inevitable downward movement of the stern will not be aided. As the stern plunges into the water past the horizontal position, there is an increased buoyancy afforded by tank 46 until the liquid level within said tank coincides with the water line.

It should be understood that either the bow or stern subsystem can work independently of each other; and, if desired, one or the other subsystem can be omitted from the design of the vessel.

Again, it should be remembered that ports 36, 48 and 50 are valve opened and remain open as long as stabilization is to be imparted to the ship. If the systems are no longer needed, the respective valves are closed by conventional means (not shown) so that pitching is not induced in vessel 10. Port 36 is closed in a manner as described above. It can also be seen that the ship need not be under way for the subsystems to be effective.

It can be seen that the present invention can be used to impart a constant force at the bow or stern of the ship to compensate for a condition which causes the ship to ride at some angle with respect to the horizontal. For example, if the stern of the ship were damaged so that the stern took on great quantities of water and lowered the stern of the vessel, tank 32 located at the bow of the ship could be entirely filled with water so that the attitude of the vessel would be brought more nearly to the horizontal. Furthermore, as another example, if it were necessary to unevenly distribute the cargo of the vessel such that the bow of the ship is lower than the stern, the water from tank 32 can be removed and ports 36 and 38 sealed off so that the bow of the ship would have increased buoyancy and, thus again, the tank corrects the attitude of the vessel to be more near the horizontal.

It should be understood that the present disclosure is of preferred embodiments and the invention should not be limited to the detailed illustrated structure. For example, the number and exact locations of the bow and stern tanks can be varied, the number of the ingress ports and outlet ports can be varied, and the number and locations of the pipes shown in the system of FIGS. 1–3 can be varied without departing from the spirit of the invention.

What is claimed is:

1. A pitch stabilization system for a water going vessel comprising liquid containing means mounted in one end of the vessel for imparting pitch stabilizing forces to the vessel in response to the fluid flowing therethrough, inlet means disposed at one end of said liquid containing means for enabling liquid to flow into said liquid containing means, and outlet means communicating with said liquid containing means for enabling liquid to flow out from said liquid containing means, said liquid containing means comprising at least a pair of pipes, each having an elbow, one of said pipes having an elbow disposed above said inlet means and the other of said pipes having an elbow disposed below said inlet means, and each of said pipes communicating with said inlet means and said outlet means.

2. A pitch stabilization system as set forth in claim 1, further comprising valve means for selectively and alternatively directing liquid that enters said inlet means through one and then the other of said pipes, and means for controlling the position of said valve means.

3. A pitch stabilization system for water going vessels comprising at least one first opening located substantially at one end of the vessel, at least one second opening defined in the sides of the vessel, and means mounted within the vessel for enabling fluid to pass through said first and second openings through a portion of the vessel, said first opening being located substantially at the front of the bow section of the vessel, said stabilization system further comprising a movable valve plate having a profile substantially the same as the profile of the bow of the vessel slidably mounted to the bow of said vessel, said plate being adapted to selectively open and close the communication between said first opening and the ambient.

4. A pitch stabilization system for water going vessels comprising a tank mounted at one end of the bow and stern sections of the vessel, inlet means extending through said vessel to enable the liquid ambient to enter the tank, said inlet means positioned vertically near the expected calm waterline and said tank having a large capacity below said inlet means so that water entering the tank through said inlet means need not overcome the static pressure head of the major portion of the water already

in the tank, and outlet means for establishing communication from said tank to the liquid ambient at a vertical position well below said inlet means.

5. A pitch stabilization system as set forth in claim 4 wherein said inlet means is positioned near the forward side of the tank and the stabilization system further comprises means for equalizing the air pressure in the tank so that water can freely enter and leave the same.

6. A pitch stabilization system as set forth in claim 5 wherein said inlet means comprises a pair of inlets each arranged on opposite sides of the vessel and each inlet communicating with the tank.

7. A pitch stabilization system for a water going vessel, comprising a stern subsystem located in the stern of the vessel and a bow subsystem located in the bow of the vessel, said stern subsystem comprising a tank, inlet means defined on at least one side of the vessel and communicating with said tank said inlet means positioned vertically near the expected calm waterline of the vessel, and outlet means defined near the rear of the vessel and communicating with said tank, said outlet means being disposed well below said inlet means, said bow subsystem comprising a bow tank, second inlet means communicating with said bow tank, said second inlet means positioned vertically near the expected calm waterline for the vessel, second outlet means defined on at least one side of the vessel and communicating with said tank, and said second outlet means being disposed well below said second inlet means.

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