

Aug. 19, 1941.

H. F. NORTON ET AL

2,253,246

METHOD AND APPARATUS FOR CONTROLLING THE METACENTRIC HEIGHT OF SHIPS

Filed Oct. 10, 1939

4 Sheets-Sheet 1

Fig. 1.

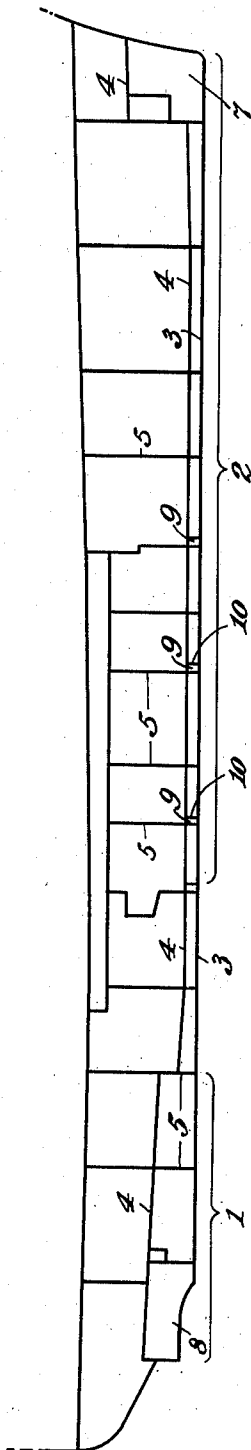
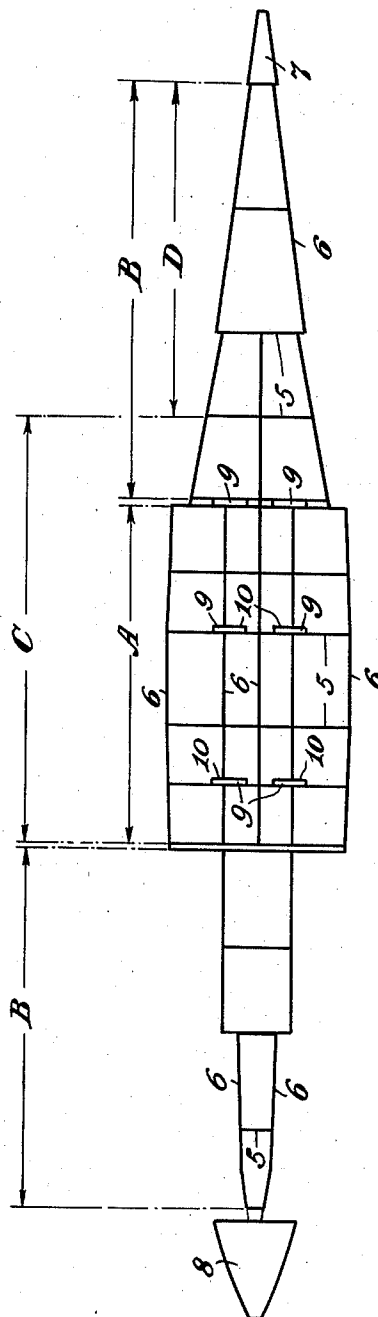


Fig. 2.



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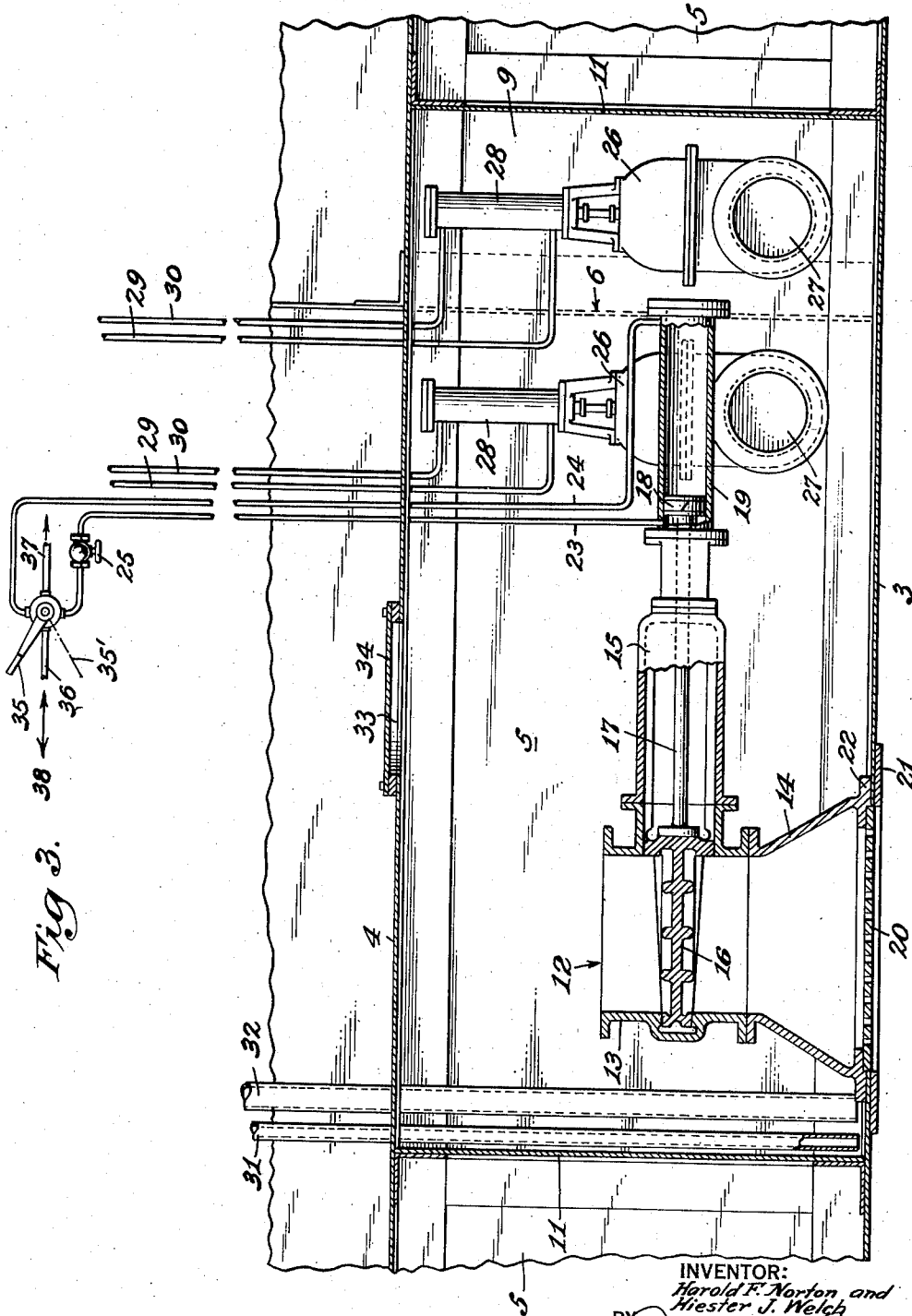
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4 Sheets-Sheet 2



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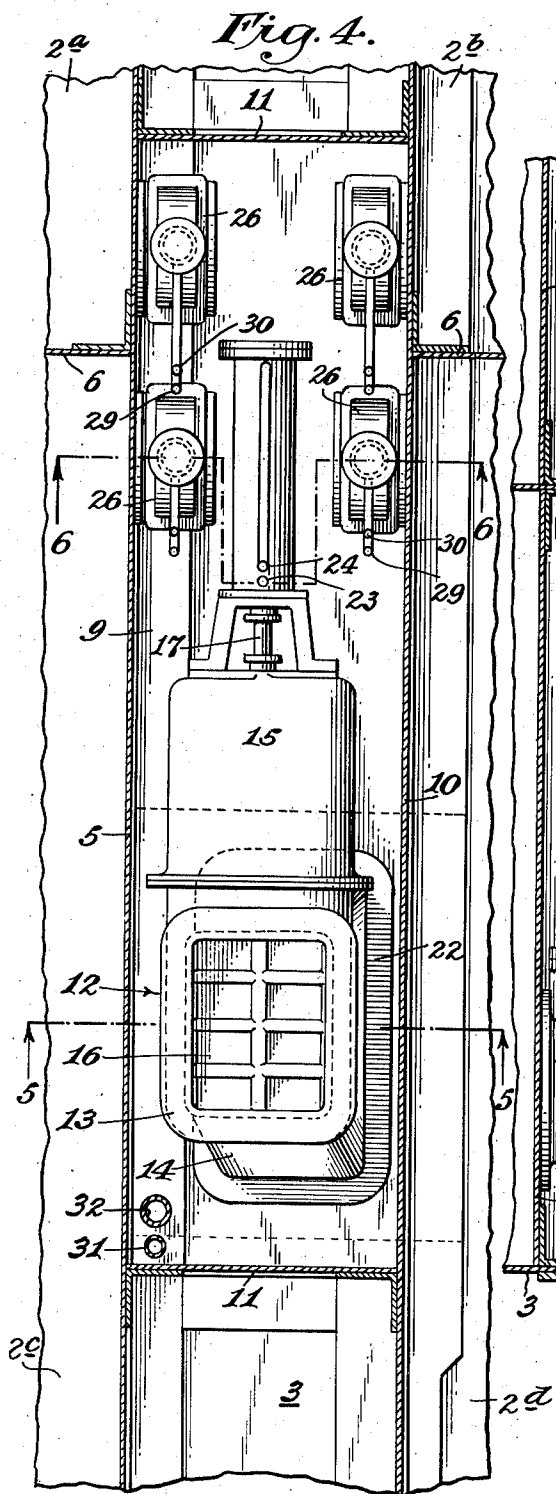
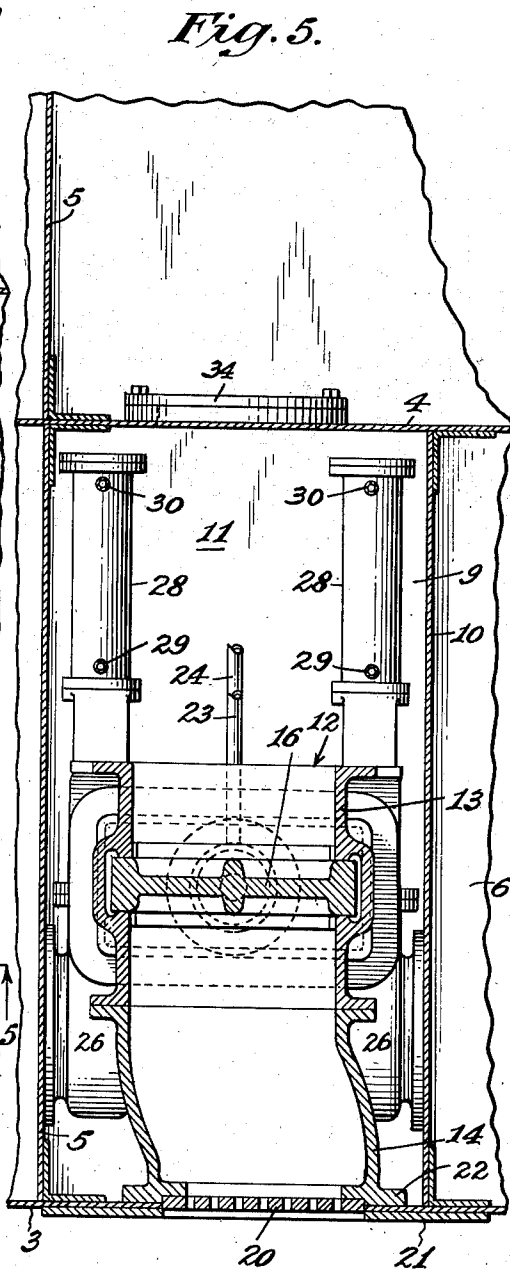
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4 Sheets-Sheet 3



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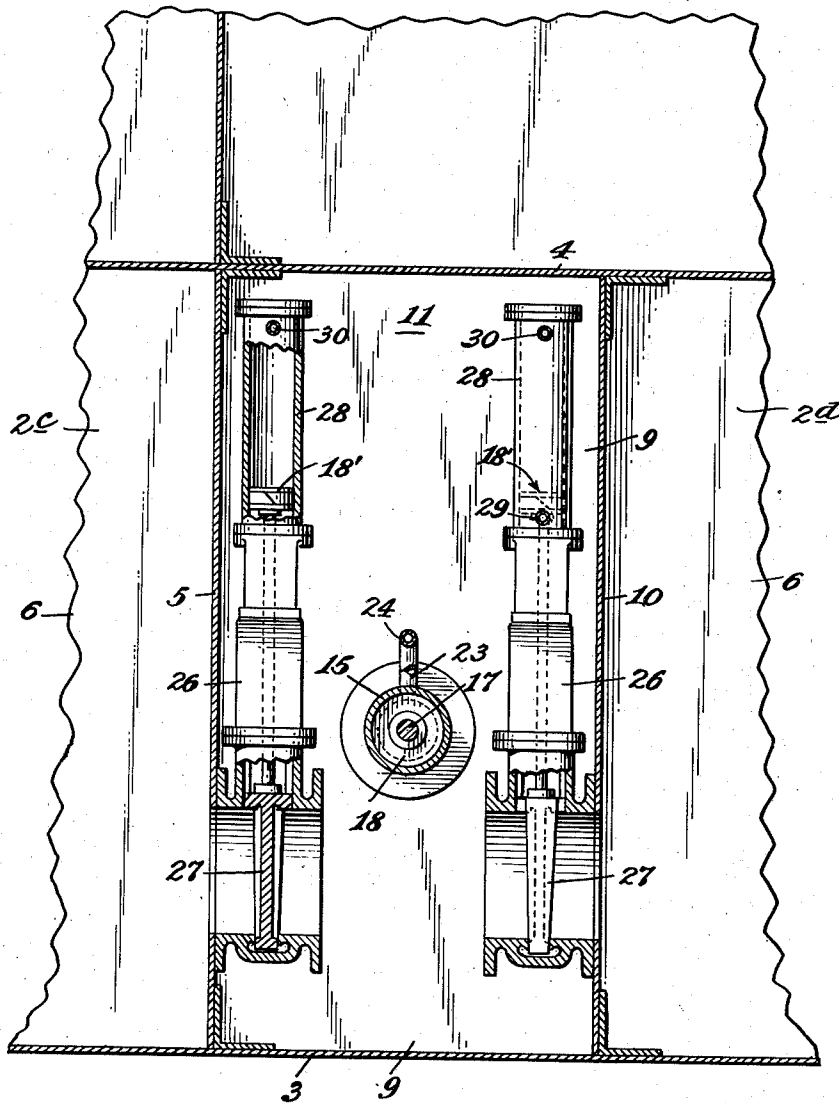
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METHOD AND APPARATUS FOR CONTROLLING THE METACENTRIC HEIGHT OF SHIPS

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4 Sheets-Sheet 4

Fig. 6.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR CONTROLLING THE METACENTRIC HEIGHT OF SHIPS

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Application October 10, 1939, Serial No. 298,754

11 Claims. (Cl. 114—121)

The invention relates to a method and means for controlling the metacentric height of ships at sea.

The fuel oil and fresh water supplies of passenger vessels are usually carried in double bottom compartments, and when these compartments are full, the stability of the ship is increased by reason of the increase in the metacentric height which is produced by the additional weight of the fuel and water in the bottom of the vessel. As the vessel proceeds on a voyage, this fuel oil and fresh water are gradually used until toward the end of the voyage a considerable number of the inner bottom tanks have been emptied and the stability of the vessel correspondingly reduced.

The present Government regulations require that a certain standard of stability be maintained throughout the entire voyage. In order to comply with these regulations it becomes necessary in accordance with present methods and equipment, for the master of the vessel to see that some or all of the inner bottom tanks are refilled with salt water ballast as they become empty. This involves pumping the salt water out of the tanks when the end of the voyage is reached, and thoroughly cleaning the tanks before they can be refilled with fuel oil or fresh water for the next voyage. This entails considerable expense and the presence of the salt water in the tanks increases corrosion and consequently adds to maintenance costs.

It is an object of the present invention to provide method and means for controlling the stability of ships through regulation of the metacentric height with water ballast, yet which in normal operation overcomes the difficulties mentioned above.

A more particular object is to provide method and means for regulating the metacentric height of vessels while in transit in such a way as to produce improved riding characteristics under safe sailing conditions while providing for a rapid increase in the metacentric height against the possibility of encountering hazardous sailing conditions.

A further object of our invention is to provide an emergency water ballast system which makes it possible normally to operate the ship without admitting water ballast to the empty inner bottom fuel and/or fresh water compartments.

A further specific object is to provide an emergency control for the metacentric height which can be operated from the bridge by a common

control which by preselection admits water rapidly to the empty inner bottom fuel and/or water tanks and/or tanks for other liquid supplies.

A further object is to provide emergency apparatus of the character described which is simple and inexpensive to construct and which does not require the use of extensive piping for admitting the water ballast to the preselected empty tanks.

It is also an object of our invention to provide a method and apparatus of the character described in which the inner bottom tanks are arranged for emergency flooding with sea water, but are effectively protected against infiltration of sea water so long as they contain other liquids or are being maintained empty.

Other objects and advantages will appear as the description proceeds.

In accordance with our invention, openings are provided in the hull for admission of water ballast to the inner bottom tanks, these openings normally being closed. The individual tanks are emptied as needed during transit, each tank being connected to a common flooding control as it becomes empty. These tanks are kept empty to maintain a low metacentric height during safe sailing conditions, but when hazardous sailing conditions are encountered the common flooding control is operated to flood some or all of the empty tanks simultaneously by admitting water through the hull openings to quickly increase the metacentric height. In accordance with our preferred system, the flooding control is operated from the bridge, and the flooding can be started instantaneously without recourse to the controls for the individual tanks. The individual selective controls may also be used to admit sea water, if necessary, to tanks that are only partially emptied of fuel oil or fresh water.

An important feature of our invention resides in maintaining, during normal or safe sailing conditions, the empty condition of the tanks from which fuel and/or fresh water has been withdrawn. This ordinarily will mean that the vessel will reach port without the necessity of admitting salt water ballast to any of the empty inner bottom tanks. This avoids the necessity of pumping ballast from the tanks and cleaning them preparatory to taking on new supplies of fuel oil and fresh water; yet this is accomplished without increasing the sailing hazards by reason of the possibility of quickly increasing the metacentric height of the ship by admitting water ballast to some or all of the empty tanks simultaneously in the event that this should be-

come necessary in order to achieve the desired stability upon encountering hazardous sailing conditions. Moreover, the additional fuel which would have been required to carry the salt water ballast will have been saved. Also, by our invention, safe operation of the ship is made possible at a small metacentric height. This results in easy motion at sea, which contributes to the comfort of the passengers.

Another important feature of the invention resides in the provision of a special cofferdam or valve chamber which is so constructed as to permit access to the valve for inspection and repair and also to permit withdrawal of such water as may seep in through the sea valves, thus effectively preventing any infiltration of such water through the cofferdam valves leading to the tanks.

A still further feature of the invention resides in the arrangement of the sea valves and cofferdams in such a way as to admit water through the hull directly into each of the tanks whereby extensive piping is avoided, while at the same time permitting the tanks to be flooded with maximum speed.

These and other features of the invention will be explained more fully in the description which follows.

In the drawings we have shown a preferred embodiment of apparatus constructed in accordance with our invention as applied to passenger ships for operation in accordance with our novel method.

Fig. 1 is an inboard profile, or diagrammatic vertical sectional view, of a ship's hull embodying apparatus operable in accordance with the invention; and Fig. 2 is a diagrammatic plan view of the double bottom compartments of the same hull.

Figs. 3, 4, 5 and 6 are detail sectional views of a preferred form of cofferdam and valve construction applicable to the hull shown in Figs. 1 and 2. Fig. 3 is a vertical transverse sectional view through the cofferdam and sea valve; Fig. 4 a horizontal sectional view showing the valve layout; and Figs. 5 and 6 enlarged vertical sectional views on the lines 5-5 and 6-6 respectively of Fig. 4.

Referring to Figs. 1 and 2, we have shown a double-bottom hull having inner bottom tanks or compartments 1 and 2 formed between the bottoms 3 and 4, transverse partitions or bulkheads 5 and longitudinal walls 6. Some or all of the compartments 1 and 2 normally carry liquid supplies intended for consumption at sea. Thus the tanks A may be considered to normally carry fuel oil, and the tanks B to normally carry fresh water. The group of tanks C, comprising all of the tanks A and some of the tanks B, as indicated in Fig. 2, are considered to be designed to hold sufficient salt water ballast to provide stability for the floodability in damaged condition required by the Government regulations applying to the ship. The tanks D, the fore peak 7 and the after peak 8 may be used in the usual way to carry fresh water or fuel oil or salt water ballast, as may be desirable in connection with the operation of the ship. As shown in Figures 1 and 2 our invention is practiced only in connection with tanks comprised in group C, but it is to be understood that it can be made to apply to whatever group of tanks best suits the operating conditions of the ship and that accomplishes the purpose of providing the necessary stability for the compartment floodability re-

quired by the Government regulations applying to the ship.

In accordance with our invention, cofferdams are arranged at the sides or corners of adjacent tanks so as to provide valve chambers 9 through which each of the compartments in group C are connected to a sea valve in the bottom 3. Preferably the chambers 9 are so arranged that each chamber affords a direct connection to three or four separate double-bottom compartments, as shown in Fig. 2.

Referring now to Figs. 3 to 6 inclusive we shall describe a cofferdam and valve arrangement which is particularly adapted to carrying out our invention. The valves shown are arranged for hydraulic operation but any other suitable type of power actuated valves may be substituted therefor. The chamber 9 affords direct connection to four of the double-bottom compartments 2, being formed by the bottoms 3 and 4, bulkhead 5, transverse cofferdam wall 10 and longitudinal walls 11. The sea valve 12 comprises housings 13, 14, and 15, and a gate 16 connected by a rod 17 to a piston 18 within the hydraulic cylinder 19. An inlet strainer 20 is provided at the entrance to the housing 14. The opening in the bottom 3 may be reinforced by a ring 21, the edge of the opening being clamped between this ring and the flange 22 of the housing 14.

The piston 18 is double acting, the cylinder 19 being connected by the pipe-lines 23 and 24 to a suitable source of hydraulic power. A valve 25 in the line 23 provides means for rendering the hydraulic gate-withdrawing means inoperative so long as the compartments adjacent chamber 9 contain fuel oil or other liquid supplies.

Smaller valves 26 are arranged to control communication between the chamber 9 and the several compartments 2. These valves may be of the same type as the valve 12, having gates 27 hydraulically actuated by double-acting pistons 18' operating in the cylinders 28. The cylinders 28 are connected by pipe-lines 29 and 30 through a suitable control mechanism to a source of hydraulic power.

A sounding tube 31 extends into the chamber 9, preferably terminating just above the bottom 3 and providing means for detecting the presence of water within the chamber 9. Another pipe 32, which also terminates just above the bottom 3, is connected to a bilge suction pump so that if there is any leakage into the chamber 9 when the valve 12 is closed, the seepage water can be evacuated, thus preventing it from reaching the level of the valves 26 and thereby insuring against any infiltration of sea water into tanks which it is desired to maintain empty, or diffusion of sea water into tanks containing fuel or other liquid supplies. A manhole 33 with a cover 34 provides access to the chamber 9 for cleaning, inspection and maintenance purposes.

It will be understood that each of the chambers 9 are provided with one or more sea valves and one or more cofferdam valves leading to the adjacent double bottom compartment or compartments.

Each of the pipe-lines 29 of the cofferdam valves in the various chambers 9 is provided with a suitable valve, such as the valve 25 previously referred to in connection with the valve 12. This provides independent control of the cofferdam gate valves 26. Also each of the pipe-lines 29 and the pipe-lines 30 lead to a common control which is preferably located on or near the bridge of the ship. Such a common control is shown

at 35 in Fig. 3, and may consist of a three-way or four-way valve, or a series of such valves, arranged on a common shaft or otherwise connected to a single actuating means. From the control 35 the pipe-line or pipe-lines 36 lead to a hydraulic pump and the pipe-line or pipe-lines 37 lead to an overboard discharge or back to the intake side of the hydraulic pump.

The ship, when embarking on a voyage, normally will have most of the inner bottom compartments 2 filled with liquid supplies such as fuel oil and fresh water. In accordance with our invention, the individual compartments are emptied as needed during transit and as each compartment becomes empty, it is connected to the common flooding control 35 as by means of opening a valve (corresponding to the valve 25) in the pipe-line 29. If the valve 25 in the pipe-line 23 leading into the particular chamber 9 which provides communication with the compartment that is being cut in to the common control has not previously been opened, it will be opened at this time to connect the valve 12 to the common control. For example, let us consider the four compartments 2^a, 2^b, 2^c and 2^d adjacent the chamber 9 as shown in Fig. 4. At the start of the voyage, these four compartments will contain—let us say—fuel oil. Now consider that compartments 2^a and 2^d are connected to the burner supply lines and become empty. The valves in the pipe-lines 29 associated with the gate valves 26 which control the opening between these particular compartments and the chamber 9 are now opened so as to connect these lines to the common flooding control 35. The line 23 likewise is connected to this common control. It may also be desirable to have valves in the lines 24 and 30 in which case these valves are also regulated in the same manner as the valves 25. The control will be in the position shown in full lines at 35, in which position the gates 16 and 27 will remain closed. As other compartments become empty, they too will be cut in to the common control but all of these compartments will be kept empty to maintain a low metacentric height during safe sailing conditions. In the event that hazardous sailing conditions are encountered at any time during the voyage, such as might be occasioned by damage to the ship or running into heavy seas, so that it becomes necessary to have greater stability, the common control 35 is moved into position 35', connecting the preselected lines 23 and 29 to the line or lines 36 leading to the hydraulic pressure source 38. This also connects the corresponding lines 24 and 30 to discharge or return line or lines 37. Thus by operating the single control 35, it is possible to flood all of the preselected empty compartments simultaneously by admitting water through the hull to quickly increase the metacentric height when hazardous sailing conditions are encountered. The flooding can be started instantaneously without recourse to the separate controls for the individual tanks, which is of great value in an emergency.

It will be understood that an electrical control system or any other suitable type of submersible operating gear may be substituted for the hydraulic control which we have shown for purposes of illustration. If desired, there may be duplicate controls on the bridge and in the engine room, or at such other locations as may be deemed expedient. Ordinarily the arrangements for flooding empty inner bottom tanks are such as to permit each tank to be flooded as it becomes

empty, the sea water being admitted or pumped through long lengths of relatively small piping. This makes it necessary to pump the salt water out of the tanks when the end of the voyage is reached and the tanks must be thoroughly cleaned before they can be refilled with fuel oil or fresh water for the next voyage. In accordance with our invention, however, it is normally possible to complete the voyage without admitting salt water ballast to any of the empty tanks, except as may be necessary for other purposes such as trimming the ship. This also creates a saving of fuel inasmuch as the additional fuel which would have been required to carry the salt water ballast will have been saved. Moreover, the ship can be operated safely at a small metacentric height which results in improved riding characteristics under normal sailing conditions.

If desired or suitable to the arrangement of the vessel, the walls of the chambers 9 may be separated from those of the tanks, so long as direct communication is maintained between the chambers and the adjacent inner bottom compartments whereby flooding can be performed quickly through large openings. The compartments 2 may and in general will, be provided with the usual venting arrangements to permit displacement of air therefrom when they are being filled with fuel oil or fresh water, or when they are being flooded. Inasmuch as such arrangements are well known in the art, it is not necessary to include a description of them here.

The term "liquid supplies" as used herein and in the appended claims refers to liquid consumable stores such as fuel oil, fresh water and the like, which are commonly carried in double bottom compartments and intended for consumption at sea.

It will be understood that various modifications can be made in the arrangement which we have specifically described while retaining important advantages of the invention. The terms and expressions which we have employed are used as terms of description and not of limitation, and we have no intention of excluding such equivalents of the invention set forth, or of portions thereof, as fall within the purview of the claims.

We claim:

1. In apparatus for controlling the metacentric height of ships, a plurality of closed tanks arranged in the ship's bottom, chambers communicating directly with the tanks and also communicating directly with openings in the ship's bottom, valves for controlling communication from the chambers to the tanks, valves for controlling communication from the chambers to the openings in the ship's bottom, and means for withdrawing water from the chambers when the valves are closed.

2. In apparatus for controlling the metacentric height of ships, a tank arranged in the ship's bottom, a sea valve in the ship's bottom adjacent the tank, a cofferdam between the tank and the sea valve, a valve in the cofferdam communicating directly with the tank at a point above the level of the sea valve, and means for withdrawing water from the space which separates the cofferdam valve and sea valve to prevent seepage water from reaching the level of the cofferdam valve.

3. In apparatus for controlling the metacentric height of ships, fuel tanks arranged in the ship's bottom, sea valves in the ship's bottom adjacent the tanks, cofferdams between the tanks and the

sea valves, valves in the cofferdams communicating directly with the tanks at points above the levels of the adjacent sea valves, and means for withdrawing water from the cofferdams to empty them after the valves have been closed following flooding of the cofferdams to fill empty fuel tanks with water ballast.

4. In apparatus for controlling the metacentric height of ships having liquid supplies tanks in the bottom, openings in the hull for admitting water to such tanks, means for closing the hull openings, means for withdrawing water seeping past the closing means to effectively seal the tanks against infiltration when the tanks contain supplies and when they are empty, means for emptying individual tanks as needed during transit, and means for flooding a plurality of such tanks simultaneously by admitting water through the hull openings to quickly increase the metacentric height when hazardous sailing conditions are encountered.

5. Method of controlling the metacentric height of ships having liquid supplies tanks in the bottom and openings in the hull for admitting water to such tanks, which comprises closing the hull openings, withdrawing water seeping past the closed openings to effectively seal the tanks against infiltration when the tanks contain supplies and when they are empty, emptying individual tanks as needed during transit, maintaining the sealed condition of the empty tanks during safe sailing conditions, and flooding a plurality of such empty tanks simultaneously by admitting water through the hull openings to quickly increase the metacentric height when hazardous sailing conditions are encountered.

6. Method of controlling the metacentric height of ships having liquid supplies tanks in the bottom, which comprises the steps of emptying individual tanks as needed during transit, keeping such tanks empty to maintain a low metacentric height during safe sailing conditions, and flooding a plurality of such empty tanks simultaneously by admitting water through the hull to quickly increase the metacentric height when hazardous sailing conditions are encountered.

7. Method of controlling the metacentric height of ships having liquid supplies tanks in the bottom, which comprises the steps of emptying individual tanks as needed during transit, keeping such tanks empty to maintain a low metacentric height during safe sailing conditions, and flooding a plurality of such empty tanks simultaneously by admitting water directly

through the bottom to quickly increase the metacentric height when hazardous sailing conditions are encountered.

8. Method of controlling the metacentric height of ships having liquid supplies tanks in the bottom, which comprises the steps of emptying individual tanks as needed during transit, keeping such tanks empty to maintain a low metacentric height during safe sailing conditions, and flooding a plurality of such empty tanks simultaneously by admitting water through the hull at points directly adjacent each empty tank to quickly increase the metacentric height when hazardous sailing conditions are encountered.

9. Method of controlling the metacentric height of ships having liquid supplies tanks in the bottom, which comprises the steps of emptying individual tanks as needed during transit, connecting each tank to a common flooding control as it becomes empty while keeping such tanks empty to maintain a low metacentric height during safe sailing conditions, and operating the common flooding control to flood a plurality of such empty tanks simultaneously by admitting water through the hull to quickly increase the metacentric height when hazardous sailing conditions are encountered.

10. In apparatus for controlling the metacentric height of ships having inner bottom tanks for liquid fuel, and chambers arranged between the shell and inner bottom in such a way that at least one chamber lies directly adjacent each tank which is to be used for auxiliary water ballast, each chamber having a valve controlling admission of water to the chamber through the shell and a valve controlling admission of water from the chamber to at least one of the tanks.

11. In apparatus for controlling the metacentric height of ships having inner bottom tanks for liquid fuel, chambers arranged between the shell and inner bottom in such a way that at least one chamber lies directly adjacent each tank which is to be used for auxiliary water ballast, each chamber having a valve controlling admission of water to the chamber through the shell and a valve controlling admission of water from the chamber to at least one of the tanks, a common control for the valves, and means for selectively connecting the valves to the common control to provide for emergency flooding of the empty tanks simultaneously while preventing diffusion of water into the tanks containing fuel.

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CERTIFICATE OF CORRECTION.

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August 19, 1941.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 50, beginning with "1. In apparatus" strike out all to and including the word and period "closed." in line 60 comprising claim 1 and for the claims now numbered 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 read 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 respectively; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of November, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.