United States Patent [19]

Larsen

[11] **3,826,098**

[45] **July 30, 1974**

[54] **METHOD AND MEANS FOR REDUCING WAVE PRESSURES ON UNDERSEA CONSTRUCTIONS**

[76] Inventor: **Jan Larsen,** Marknadsvagen 61, Taby, Sweden

[22] Filed: **Sept. 25, 1972**

[21] Appl. No.: **291,817**

[30] **Foreign Application Priority Data**

Oct. 12, 1971 Sweden 12921/71

[52] **U.S. Cl.** **61/46**

[51] **Int. Cl.** **E02d 29/00**

[58] **Field of Search** 61/46, 1, 69, 46.5

[56] **References Cited**

UNITED STATES PATENTS

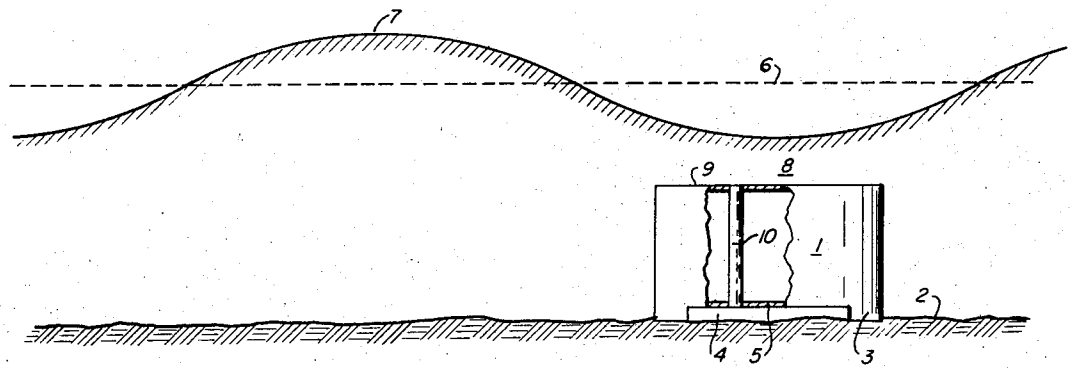
2,382,763	8/1945	Young	61/46
3,326,000	6/1967	Lamy	61/46 X
3,429,128	2/1969	Stafford et al.	61/46.5
3,708,987	1/1973	Roulet et al.	61/46

Primary Examiner—Mervin Stein
Assistant Examiner—Philip C. Kannan
Attorney, Agent, or Firm—Robert C. Baker

[57] **ABSTRACT**

A method and device for reducing lifting forces, on an undersea construction, resting on the bottom of the sea. Such lifting forces are caused by passing wave troughs which create more significant low pressures on the upper side of the construction than those low pressures at the bottom of the sea. The invention effects a pressure equalization between said two low pressure areas. Such a pressure equalization an be achieved by placing the area below the bottom of the construction in open communication with the area above the construction.

8 Claims, 4 Drawing Figures



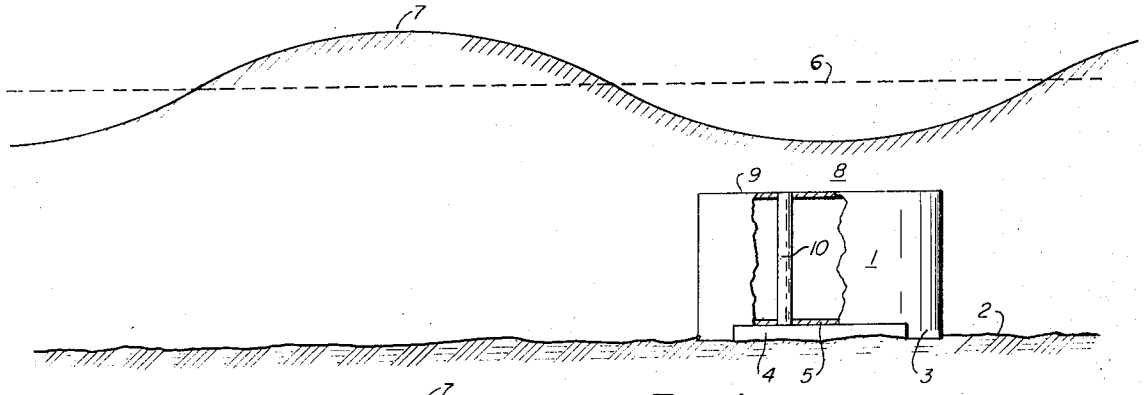


FIG. 1

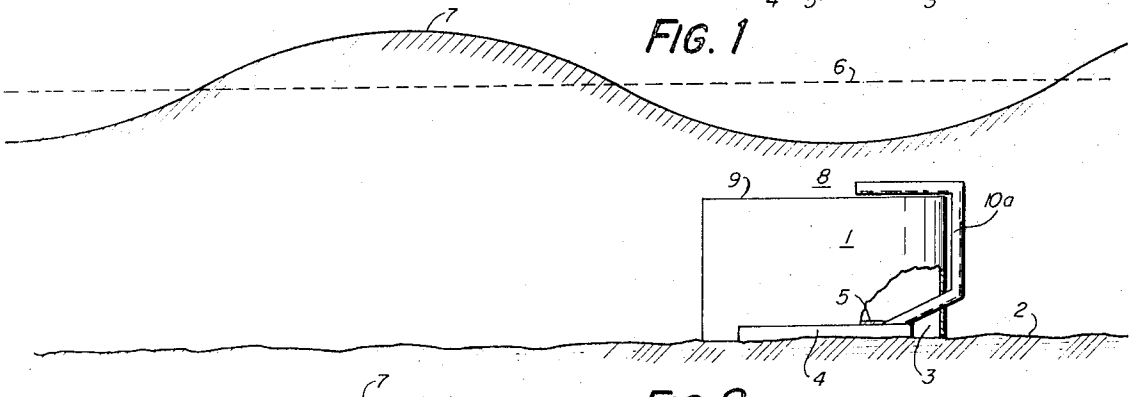


FIG. 2

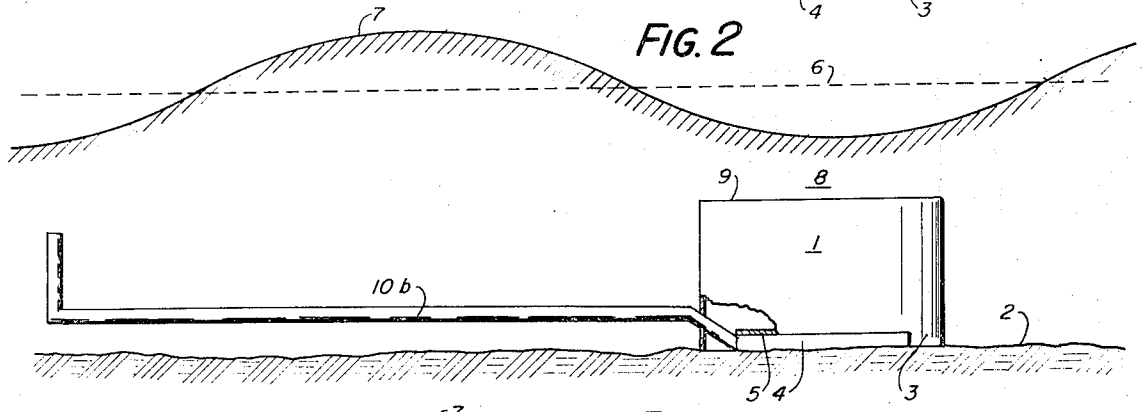


FIG. 3

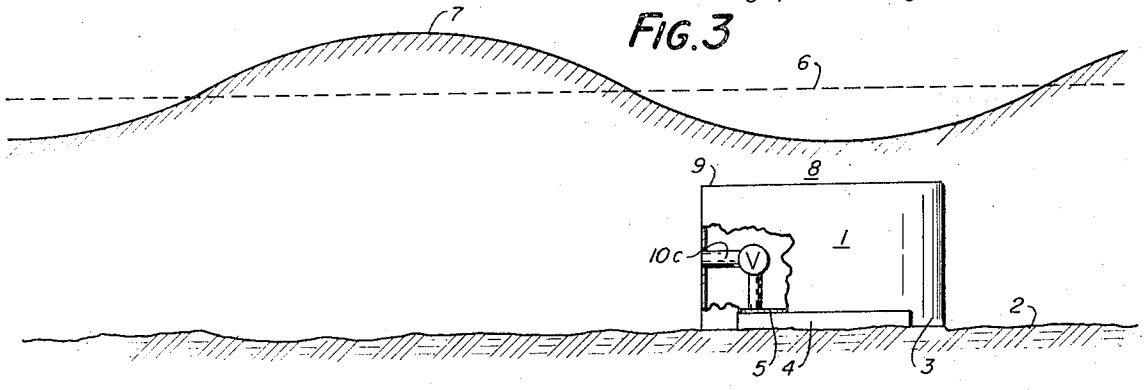


FIG. 4

METHOD AND MEANS FOR REDUCING WAVE PRESSURES ON UNDERSEA CONSTRUCTIONS

BACKGROUND OF INVENTION

The present invention relates to a method and means for reducing lifting forces acting on a construction, such as a tank or the like, placed at the bottom of the sea (which herein is used to include a lake or the like) and located beneath the surface of the water, caused by passing wave troughs.

When a wave passes over a tank construction resting on the bottom of the sea said tank is subjected to a pulsating load. During the passage of the wave trough above such a construction it is characteristic that the low pressures acting on the upper side of the construction are greater (that is, more low or reduced as a significant low pressure) than the simultaneous low pressures acting at the bottom of the sea. The last mentioned low pressure is normally transplanted below the tank and acts on the bottom of the construction. Even if the free flow under the construction is blocked in some way by the base of the construction the low pressure can, if the lower side of the construction is more or less rigid, usually be transplanted undiminished through the bottom of the sea which usually consists of sand. Due to the fact that the low pressure acting on the upper side of the construction is more pronounced or significant in effect than the low pressure acting at the bottom of the construction, the construction is subjected to an upwardly directed force (that is, an upward suction or lifting force) each time a wave trough passes. Such wave movements also cause a pulsing force directed horizontally. However, this last mentioned force need not be taken into consideration in the present context.

A number of different devices have been employed in an attempt to stabilize the position of such constructions. According to one known method the weight of the construction itself has been increased by a suitable ballast of concrete or iron. According to a further known method such constructions have been anchored to the bottom of the sea by means of piles or the like. Both these known methods are however complicated and extremely expensive.

It is an object of the present invention to provide a method for eliminating the above mentioned drawbacks without the need for any increment of the construction by a ballast of concrete or iron.

It is another object of the present invention to provide a simple and inexpensive device for substantially eliminating or reducing lifting forces from wave troughs passing over an undersea construction.

These objects and others, as well as numerous advantages of the present invention will be seen from the following disclosure.

SUMMARY OF INVENTION

According to the present invention there is provided a method by which a pressure equalization is effected between the low pressure area at the top of the construction and the low pressure area at the bottom of the construction.

Preferably the construction is provided with a pressure equalizing means effecting an open communication between the bottom of the construction and a region having lower pressure than would have been developed without this free communication, for example

with the upper side of the construction or with a region located in front of or behind (that is, laterally to) the construction, where a wave trough passes simultaneously with the passage of the wave trough across the lower side of the construction. Due to this proposed arrangement the low pressure on the upper side of the construction can be transplanted substantially undiminished to the lower side of the construction and act on the entire lower side of the construction or a part of it. The total lifting force on the construction will thereby be considerably reduced.

Low pressure of the magnitude in question can also be achieved by pumping or the like.

The preferred device or structural features of the invention are broadly characterized as follows: A device for reducing the lifting forces caused by passing wave troughs acting on an undersea tank construction which rests on the bottom of the sea and which is located completely beneath the surface of the sea water, comprising an open communication passage for sea water between the underside of said tank construction and a terminal location beneath the surface of the sea water but in elevated relationship to said underside and removed from the upper surface per se of said tank construction, said communication passage being effective to allow a pressure equalization between the effective hydrodynamic pressure acting on the upper side of the tank construction and the effective hydrodynamic pressure acting on the lower side of the tank construction as a wave trough passes said tank construction, said equalization being effected by sea water flowing upwardly through said passage away from said underside of said terminal location, thereby to reduce the upwardly directed lifting force of such passing wave trough on said tank construction.

Full details of the present invention follow herein and are seen in the accompanying drawing, made a part hereof, wherein:

FIG. **1** is a schematic side view of an undersea tank construction, with parts broken away to show an open communication passage, and with the tank construction shown in an undersea environment; and

FIGS. **2, 3,** and **4** are schematic side views comparable to FIG. **1** but showing alternate arrangements for an open communication passage as described herein.

DESCRIPTION OF INVENTION

In all figures of the drawing a tank construction is designiated **1.** The construction **1** rests on the bottom of the sea **2** with its lower part **5** suitably supported by a flange **3** projecting from the lower part **5.** A space **4** is thus formed between the bottom of the sea **2** and the lower part **5.** The average level of the water is denoted by **6** and a wave profile by **7.** Between the space **4** and a space **8** located above the upper part **9** of the construction **1** is a free connection or open communication passage in the form of a tube or the like.

In FIG. **1,** this communication passage **10** extends through the construction **1.**

The communication between the space **8** and the space **4** may also be arranged, at least in part, outside the construction **1,** as shown in FIG. **2** by tube **10***a*.

The communication may lead from the space **4** to a region located in front of or behind (that is, laterally to) the construction to a location where another wave trough passes simultaneously with the passage of the

wave trough over the construction **1**, as shown in FIG. 3 by tube **10***b*.

Alternatively, as shown in FIG. **4**, the pressure equalization strived for can be achieved by means of a pipe **10***c* provided with a pump V.

The means shown in the Figures of the drawing functions in the following manner:

When a wave trough passes over the construction, a low pressure is developed on the upper side **9** of the construction and a low pressure at the sea bottom **2**, which is transplanted entirely or partially to the part of the sea bottom which is located beneath the construction, in the space **4**. Due to the open connection passage **10** or **10***a* or **10***b* or **10***c*, the relatively low pressure acting on the upper side **9** of the construction is relatively transplanted to the space **4** at the lower side of the construction, so that the upwardly directed lifting force on the construction is considerably reduced. The pressure in the space **4** is now lower than at the sea bottom outside the construction, thus causing a certain current at the bottom of the sea, i.e. a certain flow towards the space **4**. The actual construction will be slightly deformed, the volume of the space **4** decreasing, for example, and a certain flow passing from the space **4** to the space **9**. The dimensions of the connection **10** or **10***a* or **10***b* or **10***c* should be such that this passage can take place without obstruction.

Various modificants have been disclosed; others will be obvious to those skilled in the art. Consequently, it is intended that the present disclosure be taken as illustrative and not as limiting of the present invention.

What is claimed is:

1. A method of reducing the lifting forces caused by passing wave troughs acting on an undersea tank construction which rests on the bottom of the sea and which is located completely beneath the surface of the sea water, comprising the step or providing an open communication passage for sea water between the underside of said tank construction and a terminal location beneath the surface of the sea water but in elevated relationship to said underside and removed from the upper surface per se of said tank construction, said communication passage being effective to allow a substantial pressure equalization between the effective hydrodynamic pressure acting upon the upper side of the tank construction and the effective hydrodynamic pressure acting on the lower side of the tank construction as a wave trough passes said tank construction, said equalization being effected by sea water flowing upwardly through said passage away from said underside to said terminal location, thereby to reduce the upwardly directed lifting force of sauch passing wave trough on said tank construction.

2. A method according to claim **1**, wherein the pressure equalization is achieved by a corresponding decrease in the volume of water in the region below the construction by means of pumping or the like.

3. A device for reducing the lifting forces caused by passing wave troughs acting on an undersea tank construction which rests on the bottom of the sea and which is located completely beneath the surface of the sea water, comprising an open communication passage for sea water between the underside of said tank construction and a terminal location beneath the surface of the sea water but in elevated relationship to said underside and removed from the upper surface per se of said tank construction, said communication passage being effective to allow a pressure equalization between the effective hydrodynamic pressure acting on the upper side of the tank construction and the effective hydrodynamic pressure acting on the lower side of the tank construction as a wave trough passes said tank construction, said equalization being effected by sea water flowing upwardly through said passage away from said underside to said terminal location, thereby to reduce the upwardly directed lifting force of such passing wave trough on said tank construction.

4. The device according to claim **3**, wherein said terminal location of said open communication passage is above said tank construction.

5. The device according to claim **4**, wherein at least a portion of said open communication passage extends through said tank construction.

6. The device according to claim **4**, wherein at least a portion of said open communication passage extends outside said tank construction.

7. The device according to claim **3**, wherein said terminal location of said open communication passage is located laterally away from said tank construction.

8. The device according to claim **3**, wherein a pipe provided with a pump is connected to said space below the construction.

* * * * *