Feb. 6, 1962 P. HUSKA 3,019,948

FLUID RESERVOIR

Filed July 7, 1958

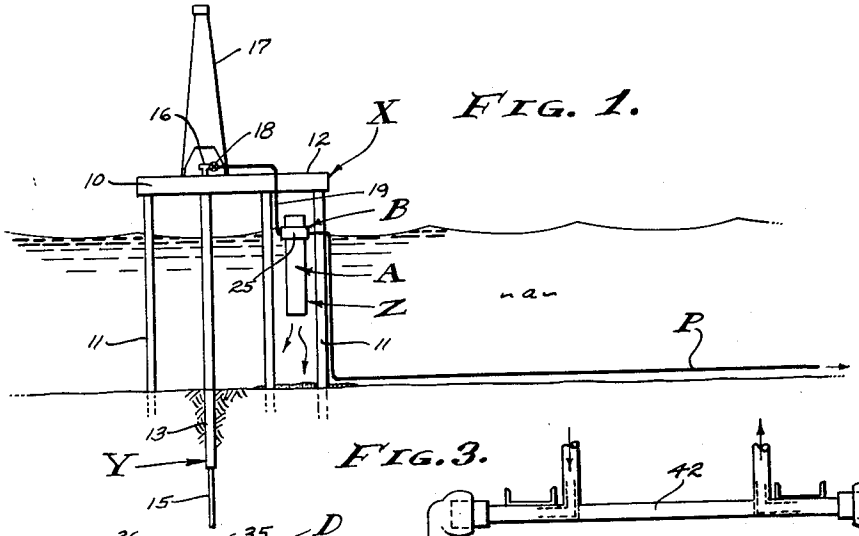


FIG. 1.

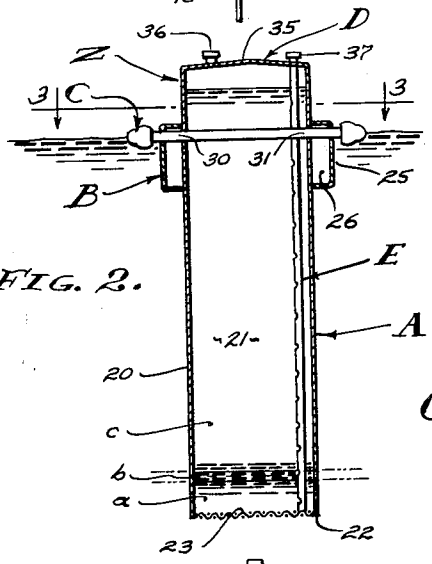


FIG. 2.

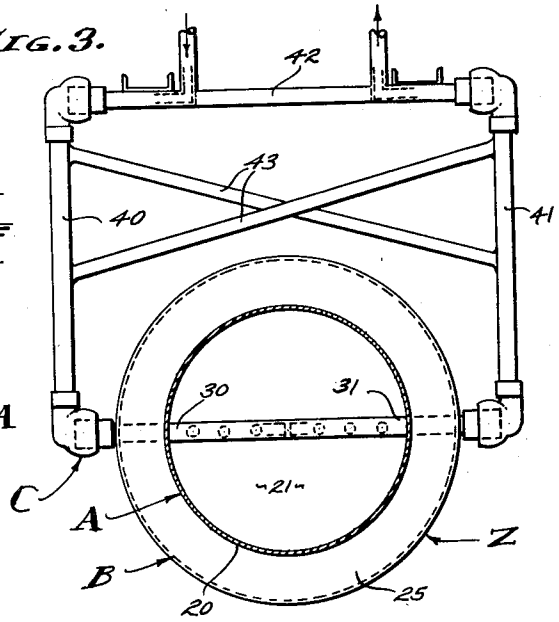


FIG. 3.

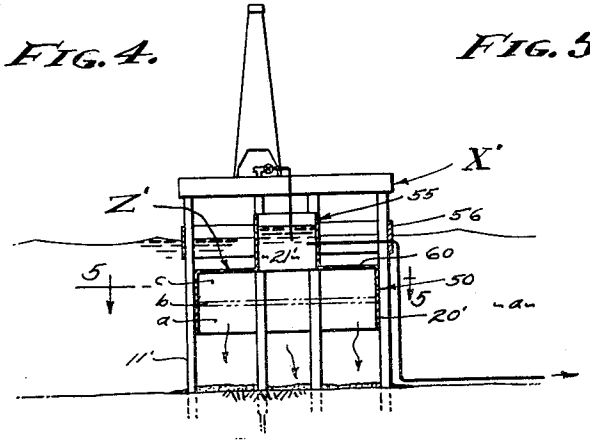


FIG. 4.

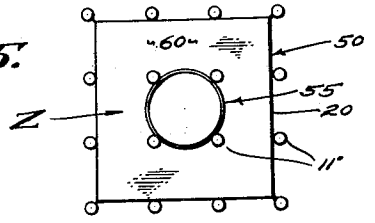


FIG. 5.

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FLUID RESERVOIR

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This invention relates to a fluid reservoir and is particularly concerned with the storage of fluids in a supporting fluid and having a density or gravity less than that of the surrounding supporting fluid, or less than that of the fluid in which the reservoir is floated, it being a general object of this invention to provide a simple and practical fluid reservoir that can support itself, that can be filled and emptied without affecting the water line level thereof, and which discharges residue that normally precipitates from the fluid stored therein.

Ordinarily, a fluid reservoir necessarily has a bottom and side walls extending upward from the bottom to form a vessel. Such reservoirs are commonly employed and are used to contain large volumes of fluid involving many tons in weight. Also, such reservoirs are cumbersome and occupy substantial areas and vertical space, and because of their usual large size require heavy construction in order to withstand the pressures and weights involved. Further, and a most important factor, the bottoms of ordinary reservoirs must be frequently cleaned due to the accumulation of precipitants.

It is an object of this invention to provide a relatively light construction in the form of a reservoir and which is adapted to handle and contain fluids having a density or gravity less than a surrounding supporting fluid. With the structure that I provide the fluid contained in the reservoir is supported by fluid surrounding the reservoir so that the structure is not subjected to fluid pressures and weight.

It is another object of this invention to provide a fluid handling reservoir that is supported independently of the support of the fluid contained therein. With the structure provided the fluid handled is supported by a surrounding fluid while the structure alone is carried by means to support it.

An object of this invention is to provide a floating reservoir for handling fluid and wherein the structure alone, and not the fluid contained therein, is supported by a surrounding fluid.

It is also an object of this invention to provide a fluid handling reservoir that does not load up with residue and which remains clean by allowing precipitants to drop therefrom. With the reservoir that I provide cleaning thereof is not necessary since there is no bottom, which would ordinarily collect residue.

Another object of this invention is to provide a reservoir of the type referred to that is stable and secure and which is reliably anchored in an upright operating position. With the structure that I provide the reservoir inherently remains upright and it is anchored in position to rise and fall with the surrounding fluid level.

It is still another object of this invention to provide means joining the reservoir, as above referred to, to fluid handling lines, for example filling and emptying lines, and at the same time allowing for vertical oscillations of the tank as caused by the changing level of the surrounding supporting fluid.

The various objects and features of my invention will be fully understood from the following detailed description of the typical preferred forms and applications of my invention, throughout which description reference is made to the accompanying drawings in which:

FIG. 1 is a somewhat diagrammatic view showing an installation of the fluid reservoir of the present invention.

FIG. 2 is an enlarged detailed sectional view of the reservoir shown in FIG. 1.

FIG. 3 is a transverse sectional view of the reservoir taken as indicated by line 3—3 on FIG. 2.

FIG. 4 is a somewhat diagrammatic view showing a second form of the invention.

FIG. 5 is sectional view taken as indicated by line 5—5 on FIG. 4.

The present invention is particularly adapted to use in the handling of a fluid such as oil and in the drawings I have illustrated a typical application thereof which involves the use of this invention in the handling of crude oil as it is produced by a well. In the case under consideration, oil wells are often carried on an island of piers or pilings located in tidelands or off-shore. In some cases the entire island floats and in other cases the island has supporting piers imbedded in the earth. In any case, however, the area and vertical space of such an island, or any similar installation, is limited, and the structures involved must be stressed to carry the weights and strains involved.

In an oil producing installation, as above described, it is necessary to provide means for preparing the crude oil for transportation. That is, impurities must be separated from the well produced fluid so that it can be transported without contaminating the transporting means or facilities. For example, crude oil is often transported by pumping it through a pipe line, in which case impurities, such as sand, must be removed so as not to injure the pumps and so as not to load up the pipe line, etc. Therefore, settling tanks are ordinarily employed at the producing well, and in the case of an island installation are placed upon the deck thereof occupying a substantial area. Further, it is often necessary to simply store large or accumulating quantities of crude on the island in which case very large and expansive reservoirs are installed on the deck thereof.

In accordance with the present invention I have provided a fluid reservoir that is adapted to handle crude oil as it is produced from a well, particularly a well located at a body of water, as for example, a well carried by an island, as above described. However, with the present invention it is not necessary to place the reservoir on a supporting structure. That is, the deck of the island need not be encumbered by the reservoir, and to the end that the island need not be stressed for this latter purpose. In practice, the entire area or deck space of such an island can be devoted to the installation of wells and directly related producing equipment.

In FIG. 1 of the drawings I have shown a typical island X of the type under consideration, and I have shown a producing well Y installed thereon and delivering production fluid into the reservoir Z that I provide. The reservoir Z receives the production fluid for storing and handling or processing thereof, and it is shown connected to a pipe line P, for example a shore line extending to a pumping station (not shown). It is to be observed that the reservoir Z is not placed on the deck of the island X and that it is simply placed at the island and in the fluid, or water, surrounding the island.

The island X is a typical man-made island and involves, generally, a platform **10** supported by piers **11**. The platform **10** is a horizontally disposed element that has a deck **12**, and the piers **11** are vertically disposed elements that are imbedded in the earth **13** and which support and carry the platform. The piers **11** are in the nature of casings and are tubular elements through which the well parts are passed to enter into the earth formation below the island. In practice, there is a multiplicity of piers **11** spaced as circumstances require and each is adapted to pass the parts of a well. Further, suitable bracing and various facilities are provided, as required.

The well Y, one of which is indicated, is shown as a typical oil well and involves, generally, a casing **15**, a production head **16**, and also a rig or derrick **17**. The

casing 15 extends through one of the pilings or piers 11 and projects downwardly into the earth formation and carries the various tubings, and the like, that are necessary in a producing well. The production head 16 can vary widely depending upon the particulars of the well and is indicated as a simple Christmas-tree with a valve 18 controlling flow of the production fluid to a production flow line 19. The derrick 17 stands over the well and is used to service the well, as required.

The reservoir Z, one of which is indicated, is shown at the island X and well Y and is provided to receive the flow of fluid from the flow line 19 and to deliver said fluid to the pipe line P. The reservoir Z handles the fluid produced by the well to store it and to settle out residue and undesirable particles that flow from the well Y. Ordinarly, more than one reservoir or settling tank is necessary on an island installation of the type under consideration, since these tanks, of ordinary construction, must be put out of service periodically and cleaned. Therefore, while one tank is being cleaned, an alternate tank is employed for handling the well production.

In accordance with the present invention I have provided a reservoir construction that may either be self supporting or that may be fixed to and supported by the island. In either case, however, the fluid contained in and handled by the reservoir is not supported thereby but its actually supported by displacing the fluid, or water, surrounding the island X. In the first form of the invention, as illustrated in FIGS. 1–3, the reservoir Z is self-supporting and is a floating reservoir, while in the second form of the invention, as illustrated in FIGS. 4 and 5, the reservoir Z' is supported by the island X'.

The reservoir Z is a floating reservoir and is adapted to be supported by a supporting body of fluid or water, and involves, essentially, side walls A. In addition to the side walls A, the reservoir Z involves, generally floatation means B, fluid handling means C, a closure D, a gage well E, and various other features of construction as later described and which may be required. In the form of the invention under consideration, the walls A that essentially form the reservoir are supported by the floatation means B, the fluid handling means C supplies fluid to and empties it from the reservoir, and the closure D covers the reservoir. In addition to the foregoing elements the reservoir Z involves anchoring means adapted to position the reservoir relative to the structure of the island X.

The walls A are provided to confine or contain the fluid *c* handled by the reservoir and to separate said fluid from the surrounding fluid, or water *a*. In this form of the invention the walls A are simple vertically disposed walls and the reservoir is preferably round in plan configuration. Thus, the reservoir walls A are formed of a cylindrical body of material 20 establishing a vertically disposed chamber 21. Fluid *c* is confined to the chamber 21 while the fluid *a* is excluded from the chamber 21 and is maintained at the exterior of the reservoir when the fluid *c* is contained therein.

The floatation means B of the reservoir Z is provided to carry the reservoir structure in the supporting body of fluid *a*. The means B may vary in form and is preferably a vessel-like structure that surrounds the walls A. As shown, the means B involves a member or tank 25 that surrounds the cylindrical body 20 and which establishes a closed floatation chamber 26. The member or tank 25 is of sufficient capacity to support the weight of the reservoir when it is in operating position in the fluid *a*, and whether or not it is filled to capacity with fluid *c*.

The fluid handling means C is provided to supply and empty the fluid *c* from the chamber 21 and involves one or more fluid handling conduits that enter the chamber 21. In the preferred form of the invention there are two fluid handling conduits 30 and 31 that open into the chamber 21 at about the water level of the body of fluid *a*. As shown, a supply conduit 30 delivers fluid into the chamber 21, while an emptying conduit 31 exhausts fluid from the chamber 21. The conduit 30 is connected into the flow line 19, and the conduit 31 is connected into the pipe line P, all in order to process the production fluid of the well Y.

The reservoir Z, as thus far described, is of substantial vertical extent, projecting above and below the floatation means B and the level of the fluid *a*. Various types of fluids *c* can be handled by the reservoir Z, providing that the density or gravity of the supporting fluid *a*, and in the case of crude oil the weight ratio relative to sea water is about 1/7 to 1/8 differential. Therefore, about 1/7 of the body 20 projects above the fluid level while 6/7 thereof depends into the fluid *a*. It is to be understood, however, that said proportions may be varied as circumstances require.

In accordance with the invention, the top and bottom of the reservoir Z and body 20 thereof are open. That is, the upper end of the body 20 is open to atmosphere while the bottom end thereof is in open communication with the body of fluid *a*, the walls A extending between the top and bottom ends being imperforate. Therefore, before the fluid *c* is introduced into the chamber 21 the fluid *a* enters therein seeking a level coincidental with the fluid level at the exterior of the reservoir. When fluid *c* is introduced into the chamber 21 it displaces its weight of fluid *a*, and since it is lighter than fluid *a* it floats thereon to be supported by the heavier fluid. It will be apparent that the level of the fluid *c* will be higher in the chamber 21 than the level of the fluid *a* at the exterior of the reservoir, and that the level of the fluid *a* within the chamber 21 will be lowered by presence of the superimposed body of fluid *c*. Further, any volume of fluid *c* can be introduced into the chamber 21 until the level of the fluid *a* within the chamber reaches the lower end of the reservoir. In practice, however, a marginal distance is left remaining between the level of fluid *a* within the chamber 21 and the lower rim 22 of the body 20, as indicated.

Under operating conditions, the fluid *c* introduced into the chamber 21, for example production crude oil, contains impurities and foreign matter that will quickly precipitate and fall toward the lower end of the reservoir. The bottom of the reservoir is open and unobstructed, except for the presence of a protective screen 23, so that precipitants drop through and from the reservoir, providing said precipitants are also heavier than the fluid *a*. There are, however, some precipitant materials that will not penetrate the level of the fluid *a* and which stop between the two bodies of fluid *a* and *c* forming a third body of fluid *b*. This third body of fluid *b* will accumulate and may be drawn out of the chamber 21 through the conduits 30 or 31 by first drawing out the fluid *c* bringing the body of fluid *b* to the level of said conduits. However, the greater portion of precipitants are heavier than sea water and thus settle to the sea floor, as indicated.

The closure D is provided to protect the fluid *c* within the chamber 21 and involves a top 35 that overlies the upper end of the body 20 closing the upper end of the chamber 21. In order to open the chamber to atmosphere, or to vent said chamber into a gas line or the like, I provide an air vent 36 that prevents entry of foreign substances into the chamber and which freely passes air into and out of the chamber. If so desired, the closure D can be left imperforate in which case the chamber 21 can be pressurized.

The gage well E is provided to accommodate an instrument or suitable devices for determining the various levels of fluid within the chamber 21, as circumstances require. As shown, the gage well E is a tubular element that is perforated throughout its length and which is coextensive with the height of the body 20. The well E opens at the exterior of the reservoir for access thereof and may be capped at 37.

The anchoring means is provided to position the reser-

voir, as thus far described, and can be any suitable means for restricting the reservoir, to the desired location. In the form of the invention under consideration, the reservoir Z is associated with the island X and is to be positioned at the island. The reservoir is advantageously positioned beneath the platform **10** or alongside the platform **10** where it is supported by the fluid *a*. The anchoring means that I have shown involves articulated arms **40** and **41** that are pivotally secured to the island X and which are pivotally connected to the reservoir Z. The arms **40** and **41** are like arms that are spaced and parallel with each other and which normally lie in a horizontal plane. The inner ends of the arms are journaled to a base **42** and on a transverse axis laterally offset from the body **20** of the reservoir, and the outer ends of the arms are journaled to trunnions that project from the exterior of the body **20** on a transverse axis extending through the body **20**. The said axes are parallel and the latter axis extends diametrically of the body **20**.

In carrying out the first form of the invention, the conduit **30** is incorporated in the arm **40** while the conduit **31** is incorporated in the arm **41**. Therefore, the arms **40** and **41** are tubular elements and the journaled connections are in the form of fluid handling swivel joints. The swivel joints are preferably ball bearing type joints, as indicated, and are provided with seals, to the end that the arms **40** and **41** are free to swing and to conduct the flow of fluid. Further, the arms **40** and **41** are cross braced as by diagonal struts **43** in order to prevent side sway.

With the base **42** secured to the island X the reservoir Z is free to ride and to be supported on the body of fluid *a*. Since the weight of the fluid *c* and *b* are supported by the fluid *a*, the overall structure involve can be lightly constructed, or relatively so. Therefore, light weight materials can be employed in building the reservoir Z, and I contemplate the use of non-corrosive plastic materials that are light weight. However, any suitable materials can be used in the building of the reservoir, as required.

In FIGS. 4 and 5 of the drawings I have shown the reservoir Z′ that is supported by the structure of the island X′. In this instance, it is contemplated that the level of the fluid *a* will remain substantially constant, in which case it is practical to fix the body **20′** of the reservoir Z′ to the island structure. In this form of the invention I have illustrated a reservoir Z′ of substantial capacity underlying the entire plan area of the island X′. More specifically, the reservoir Z′ is coextensive with the area of the island X′.

The island X′. is a typical island of the type under consideration and has a platform **10′** supported by piers **11′**. As shown, there is a multiplicity of piers **11′**, some at the exterior of the island and some at the interior thereof. Since the piers **11′** extend into the body of fluid *a* they are employed to carry and support the walls A′ of the reservoir Z′ so that the lower end thereof occurs about 6/7 below the normal level of the fluid *a* and so that the upper end occurs about 1/7 above said level. The body **20′** of the walls A′ is composed of flat panels extending intermediate the piers **11′**, the top and bottom of the reservoir Z′ being open.

In carrying out the second form of the invention, account is taken of the wave motion and surging that may take place at or near the level of the fluid *a*. Therefore, the reservoir Z′ is sectional, there being a lower section **50** coextensive with the island area, and an upper section **55** of reduced size. The two sections **50** and **55** are joined by a fluid tight bulkhead **60** that is shown as being horizontally disposed and positioned well below the level of the fluid *a*, and therefore, below any substantial fluid motion. The upper section **55** is protected by being located centrally of the island Z′ within the confines of a suitable encompassing breakwater or baffle **56**. Since the upper section **55** is to project above the fluid level, it is made cylindrical in form to withstand fluid pressures from within the chamber **21′** thereof.

In all respects, except as above specified, the reservoir Z′ may be the same as the reservoir Z above described.

From the foregoing it will be apparent that I have provided an extremely simple and inexpensive reservoir construction that not only contains a fluid but which also handles said fluid to process it. That is, the fluid is stored and is also handled to be cleaned by allowing precipitation to occur, all without accumulating a residue in the reservoir chamber. Further, the structure of the present invention is such that high stresses are eliminated so that light materials can be employed in the building thereof. Also, the structure carries itself, if desired, by floating it in the supporting fluid, said supporting fluid being employed to support the fluid contained in and handled by the reservoir.

Having described only the typical and preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

Having described my invention, I claim:

1. An offshore reservoir adapted to contain a fluid of low gravity separate from a sea of surrounding high gravity fluid, and including, a vertically disposed wall encompassing the low gravity fluid and open at its lower end to be in communication with the high gravity fluid, said wall comprising a body secured to a fixedly positioned supporting structure projecting upward from the bottom of the sea to have predetermined portions thereof projecting above and below the level of the surrounding high gravity fluid.

2. An offshore reservoir adapted to contain a fluid of low gravity separate from a sea of surrounding high gravity fluid, and including, a vertically disposed wall encompassing the low gravity fluid and open at its lower end to be in communication with the high gravity fluid, said wall comprising a body fixed to a floatation means to have predetermined portions thereof projecting above and below the level of the surrounding high gravity fluid, and fluid handling means entering into the reservoir at the level of the high gravity fluid surrounding the reservoir so as to be below the level of said low gravity fluid.

3. An offshore reservoir adapted to contain a fluid of low gravity separate from a sea of surrounding high gravity fluid, and including, a vertically disposed wall encompassing the low gravity fluid and open at its lower end to be in communication with the high gravity fluid, said wall comprising a body fixed to a floatation means to have predetermined portions thereof projecting above and below the level of the surrounding high gravity fluid, and fluid handling means entering into the reservoir at the level of the high gravity fluid surrounding the reservoir, and a pivotal tubular arm projecting from an adjacent fixedly positioned structure and in communication with said fluid handling means and articulately anchoring the reservoir in working position.

4. An offshore reservoir adapted to contain a fluid of low gravity separate from a sea of surrounding high gravity fluid, and including, a vertically disposed wall encompassing the low gravity fluid and open at its lower end to be in communication with the high gravity fluid, said wall comprising a body fixed to a floatation means to have predetermined portions thereof projecting above and below the level of the surrounding high gravity fluid, and fluid handling means entering into the reservoir at the level of the high gravity fluid surrounding the reservoir, and a pair of spaced pivotal tubular arms projecting from an adjacent fixedly positioned structure and in communication with said fluid handling means and anchoring the reservoir in working position.

5. An offshore reservoir for incorporation in a struc-

tural island comprising a plurality of laterally spaced vertically disposed piers projecting from a sea bottom and surrounded by a high gravity fluid and adapted to contain a low gravity fluid separate from said surrounding fluid, and including, vertically disposed walls fixedly carried by the piers of the structure and extending above and below the level of high gravity fluid surrounding the structure and encompassing the low gravity fluid and open at its upper and lower end to be in communication with atmosphere and with the high gravity fluid respectively.

6. An offshore reservoir for incorporation in a structural island comprising a plurality of laterally spaced vertically disposed piers projecting from a sea bottom and surrounded by a high gravity fluid and adapted to contain a low gravity fluid separate from said surrounding fluid, and including, vertically disposed walls fixedly carried by the piers of the structure and having an upper section extending above and a lower section depending below the level of high gravity fluid surrounding the structure and encompassing the low gravity fluid, said sections being in open communication with each other and said lower section being of substantially large area and in open bottom communication with the high gravity fluid and said upper section being of reduced area and open to atmosphere, the upper section being coupled to the lower section below the level of fluid surrounding the reservoir.

7. An offshore reservoir for incorporation in a structural island comprising a plurality of laterally spaced vertically disposed piers projecting from a sea bottom and surrounded by a high gravity fluid and adapted to contain a low gravity fluid separate from said surrounding fluid, and including, vertically disposed walls fixedly carried by the piers of the structure and having an upper section extending above and a lower section depending below the level of high gravity fluid surrounding the structure and encompassing the low gravity fluid, said sections being in open communication with each

other and said lower section being of substantially large area and in open bottom communication with the high gravity fluid and said upper section being of reduced area and open to atmosphere, the upper section being coupled to the lower section below the level of fluid surrounding the reservoir, and a baffle overlying the lower section and encompassing the upper section.

8. An offshore reservoir for incorporation in a structural island comprising a plurality of laterally spaced vertically disposed piers projecting from a sea bottom and surrounded by a high gravity fluid and adapted to contain a low gravity fluid separate from the surrounding fluid, and including, vertically disposed wall sections fixedly carried by said piers of the structure, there being an upper section extending above and a lower section depending below the level of high gravity fluid surrounding the structure and encompassing the low gravity fluid, the upper section being of reduced area and coupled by a horizontally disposed plate to the lower section below the level of fluid surrounding the structure, and the lower section being composed of panels extending between and carried by said piers, said sections being in open communication with each other and the upper section in communication with atmosphere and the lower section terminating at a lower rim whereby the bottom of the reservoir is in open communication with the high gravity fluid surrounding the reservoir.

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