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[54] **COLLAPSIBLE CONTAINER**
14 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **114/0.5;** 222/395
[51] **Int. Cl.** **B63b 35/00**
[50] **Field of Search** 222/386.5, 107, 95, 395; 141/Inquired; 114/0.5T, 0.5; 220/18

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ABSTRACT: The invention relates to a lightweight liquid holding tank adapted to convey a liquid from a subsea storage facility to the water's surface. The tank includes a controllably buoyant hull from which an upright canopy support depends. A collapsible canopy is peripherally fastened to the hull and to the support respectively. A collar, operably carried on the support, engages the canopy whereby to permit displacement of the latter between advanced and retarded positions along the support. The canopy when expanded defines a liquid holding compartment, and when contracted, is collapsed by external pressure into contact with the hull.

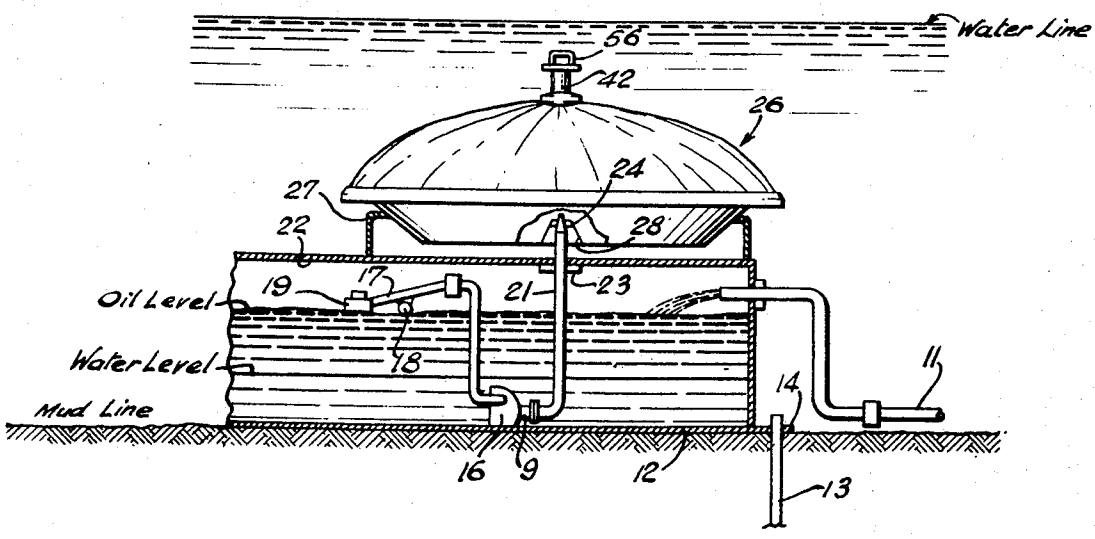


Fig. 1.

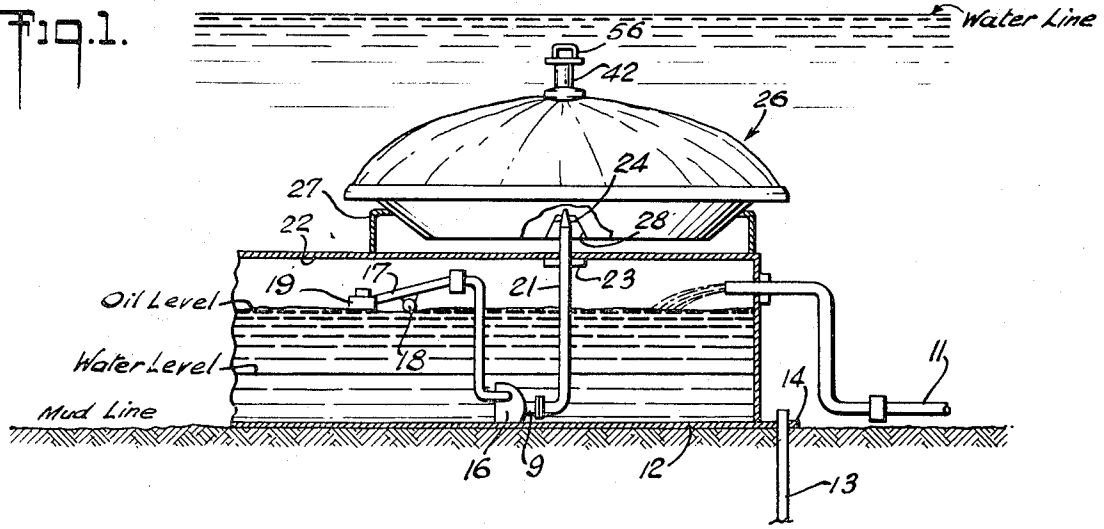


Fig. 2.

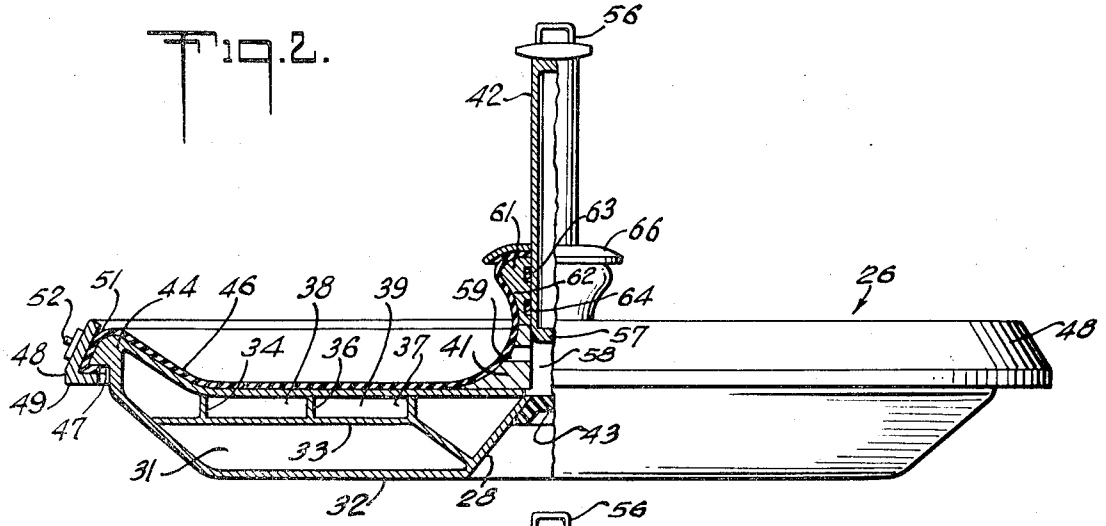
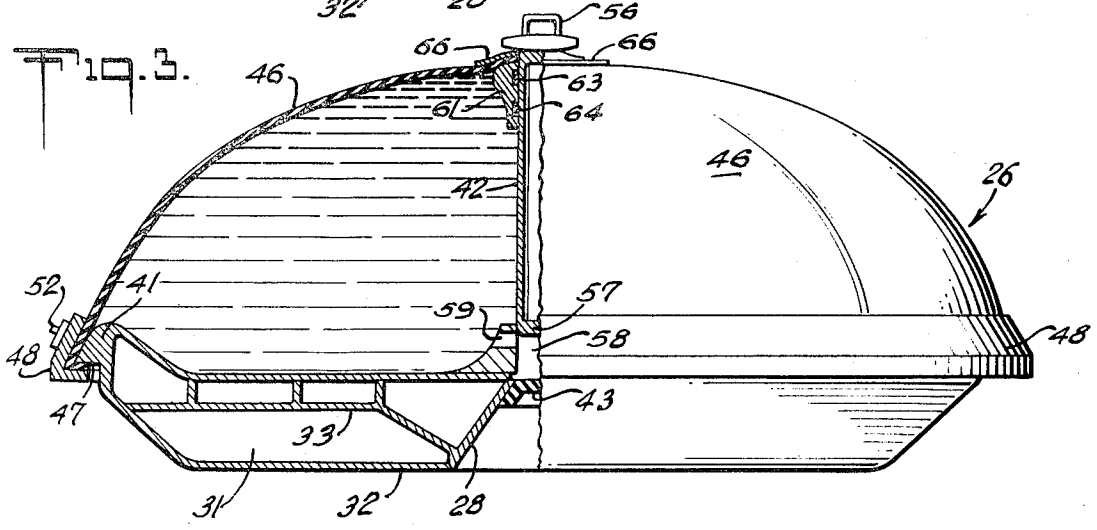


Fig. 3.



COLLAPSIBLE CONTAINER

BACKGROUND OF THE INVENTION

Exploration for, and the development of future sources of crude oil have gravitated more toward offshore sites. For example, many offshore areas including portions of the Gulf of Mexico and the Santa Barbara region in California, have proven to be abundant in crude and usable gas. When the over cover of water does not exceed three or four hundred feet, these sources can be tapped, and wells produced by resort to equipment and technology presently available.

However, it has become more apparent that future sources of supply will have to be sought and drawn from deeper offshore sites. As the depth of water increases, and as the distance from shore likewise increases, the problems inherent to an exploring and producing operation escalate commensurably. Such problems are not confined merely to means for obtaining crude oil from the earth, but to the subsequent means for conveying the crude product to a refining facility.

It should be noted that the terminology "offshore", as presently and herein used, refers to tideland areas such as an ocean or bay as well as a land locked body of water.

Under ideal circumstances, the withdrawn crude product is piped directly from well head to refinery. Where, however no piping facility is available, resort must be had to tankers, barges or similar means for transferring the liquid. In either instance, the relative cost of operating, and the potential of the oil well or field, are both factors for consideration in determining the most feasible means of transporting the oil.

Among the most practical means for providing a relatively constant flow of oil to a land based refinery or storage area, is by accumulating a predetermined amount of crude oil at a central gathering point communicated with several offshore wells or fields. From this central point, the oil is readily carried to the refinery by the above mentioned tankers or pipeline. In the instance of an oil field with uncertain potential, the feasibility of laying a permanent underwater pipeline is not justified. However, the use of tankers, barges or similar vessels for transferring the crude to the shore refinery is likewise not always financially justified.

One solution peculiar to a relatively provisional facility, is to store the crude liquid in a subsea unit, then periodically remove quantities by way of a transferable tank adapted to carry liquids from the underground storage to the water's surface. The primary drawback to such an arrangement is that the water depth at which the oil is stored, requires the transfer tank to be heavily constructed to withstand the underwater pressure. Thus the construction of such a device will normally include relatively heavy walls together with necessary internal bracing to permit the unit to withstand the subsea pressures.

It is therefore one of the objects of the invention to provide a relatively lightweight liquid holding tank adapted for deep water use. A further object is to provide a liquid holding tank adapted to transverse extreme water depths without being subject to the pressures normally present at such depths. A still further object is to provide a lightweight tank including a yieldable structure adapted to collapse when under external pressure, and to be outwardly expandable thereby to define a liquid holding chamber. Still another object is to provide a lightweight, liquid holding tank adapted to be floatably supported on the water's surface, and thereafter to be lowered to an oil well storage facility whereby said tank might be filled with stored oil or transferred to the water's surface.

In overcoming the herein stated problem with respect to oil and liquid storage, and in achieving the enumerated objectives, there is presently provided a lightweight liquid holding transfer tank adapted for safe convenient submergence to great water depths. The lightweight tank includes a saucerlike flotation hull that will sustain the tank when in unfilled or partially filled condition, at the water's surface. A fluid-tight flexible canopy sealably connected to the hull outer edge is slidably carried on a support column depending from the hull whereby to define a collapsible liquid storage compartment.

The tank is submergible at an offshore oil storage site to conveniently engage an underwater storage reservoir.

During descent of the tank, external water pressure urges the canopy inward into abutting engagement with the hull surface thereby eliminating the liquid storage compartment. Subsequent pressurized filling of the compartment urges crude oil into the latter as to expand the canopy outwardly. Upon being filled or partially filled, the transfer tank is separable from the reservoir and may be raised to the water's surface to be barged or airborne to a shore based facility.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an environmental view of the present collapsible tank communicated with a subsea, liquid holding reservoir.

FIG. 2 is an enlarged view in partial cross section of the present liquid transfer tank with the flexible canopy shown in the collapsed position.

FIG. 3 is similar to FIG. 2 showing the flexible canopy in the expanded position defining the liquid holding compartment.

Referring to FIG. 1, an offshore installation of the type presently contemplated is illustrated and includes an underwater field consisting of one or more crude oil producing wells. The well heads are at or near the ocean floor and dispersed about a limited area, each being communicated by a pipe or conduit **11** to a main reservoir or storage means **12**. The latter comprises a storage vessel formed of steel, concrete, or other material adapted to use in the underwater environment. Vessel **12** is anchored to the ocean floor by piles **13** passing through a skirt or foundation member **14**, and imbedded into the ocean substratum.

Vessel **12** may itself be fully, or at least partially imbedded into the floor as a protective measure, however anchoring by piling is normally found to be sufficient.

Crude liquid product received from the dispersed wells is normally under considerable gas pressure and is delivered to the central storage area at vessel **12** through a manifold system of the necessary pipes, valves and regulators needed to assure a smooth flow. Vessel **12** may as shown, be in the form of a rigid walled container adapted to hold crude oil only. As a matter of practicality however the vessel is usually provided with means to transfer water to and from the storage compartment to maintain the latter in a constantly full condition as the quantity of held oil is varied.

While not presently shown, the underwater facility may be provided with means for separating crude oil into gaseous and other liquid components. In this instance, the degasified crude product would be stored, and the removed gaseous element conducted to the surface either for burning or otherwise disposed of.

Vessel **12** is equipped with the usual liquid flow control means which are automatically or remotely operable. This feature is particularly desirable at water depths exceeding safe diver access depth. Vessel **12** further includes an internal pumping system comprising a pump **16**. The latter embodies a suction inlet **17** communicated with a float level mechanism **18**, which functions to maintain nozzle **19** in the oil pool whether or not the tank holds water as well as the crude oil.

Pump **16**, normally supported on the floor of the reservoir, includes a discharge **9** communicated with an elongated conduit **21** extending upwardly to and through the vessel's roof **22**. A circular collar or fastener **23** sealably positions conduit **21** uprightly with nozzle **24** extending externally of the wall **22**. Elongated nozzle **24** is supportably positioned to communicably engage the mating receptacle **28** of transfer tank **26** for automatically providing a flow of crude oil to the transfer tank when the latter is locked onto vessel **12**.

A cradle **27** or docking facility supported above vessel **12** includes a rigid guide member. The latter is outwardly flared at the remote upper end to define a seating guide surface for the underside of transfer tank **26** when the latter is being locked into place. At such time, nozzle **24** is sealably received

in tank receptacle **28** to form a leak tight annular seal thereby permitting the flow of liquid from vessel **12** to the tank **26** storage compartment whereby the pump pressure causes outward expansion of the tank collapsed canopy **36**.

Referring to FIG. **2** tank **26** includes a rigid base or hull **31**. The latter is considered a hull since it incorporates controlled buoyancy chambers which, when evacuated, will floatably support the transfer tank. Further, flooding of the buoyancy chambers will cause the tank to submerge for connection to the vessel **12**.

Hull **31** includes an outer base plate **32**. An inner wall **33** is spaced from said plate to define an interwall liquid holding compartment. A series of baffles welded between said base plate and inner wall rigidize and reinforce the base as well as compartmentalize the hull.

As shown in FIGS. **2** and **3**, baffles **34**, **36** and **37** are generally circular in configuration, being concentrically disposed with respect to the hull to form a series of concentric compartments. Radially disposed panels such as **38** and **39** are terminally connected to the circular baffles whereby to form discrete, circularly arranged segmented chambers.

Each of said segmented chambers is water tight and communicated with a manifold system to regulate the water content of the compartment and consequently the balance and buoyancy of hull **31**. While not shown in detail, the manifold system includes necessary piping, valves and regulators, being interconnected with one or more pumps such as pump **16**, to controllably regulate the fluid content of the respective buoyancy compartments.

Hull **31** is generally saucerlike in configuration, having one or more hubs **41** upstanding from the inner surface thereof. In the present arrangement, the center positioned hub **41** is adapted to receive and anchor the lower end of canopy support **42** within a cavity adapted to tightly engage the support column.

Base plate **32** of the hull includes means to facilitate engagement of transfer tank **26** with the storage vessel **12** prior to, and during transfer of crude oil from the vessel **12** to tank **26**. Base plate **32** thus incorporates receptacle **28** in the underside thereof. The receptacle is formed with an inwardly tapered frustoconical wall which leads to a sealing ring **43** at the receptacle's constructed end. Ring **43** is adapted to slidably accommodate and lock around nozzle **24** thereby to form a fluid-tight annular seal and provide communication between tank **26** and vessel **12**. Ring **43** further incorporates a controllable check valve means permitting unidirectional flow of liquid from the tank's liquid storage compartment during such time as the flexible canopy **46** is being inwardly urged thus expelling liquid from the storage compartment during descent into deep water.

The inner wall **32** of hull **31** is peripherally terminated at a rim **44**. The external surface of hub **41**, rim **44**, and the intermediate connecting area therebetween comprises a relatively smooth continuous surface against which collapsible canopy **46** may be urged without risk of damage to the latter. Peripheral rim **44** as shown includes a frustoconical seat **47** against which canopy **46** is compressed to form a fluid-tight annular joint about the hull. Seat **47** may be serrated or otherwise contoured to provide a firm gripping surface against the canopy edge when compressed by sealing ring **48** which includes a lower lip **49** and a clamping face **51**.

Ring **48**, although extending completely about the tank, is preferably segmented and adapted to be inwardly urged by fastening means **52** such as bolts, clamps, or the like spaced about ring **48** and fastened into seat **47**.

Referring to FIGS. **2** and **3**, center canopy support column **42** is rigidly held in hub **41** in a generally upright position. The column upper end includes a ring or a similar connection **56** for engaging a lifting mechanism whereby the tank is raised from the water. The latter permits tank **26** to be hoisted to the deck of a vessel, or even lifted by helicopter for transporting a full tank from a well site to a shore position.

Column **42** is cylindrical, having a curved deflecting wall **57** at the lower end disposed across fuel flow passage **58**. Wall **57** is preferably formed with a concave surface to deflect a liquid flow from nozzle **24**, into radial ports **59**. One or more such ports are disposed about hub **41** to communicate with holding compartment beneath canopy **46**.

Collar **61** is operably carried on column **42**, being slidable from a lower, retracted position as shown in FIG. **2**, to an advanced position as shown in FIG. **3**. Collar **61** includes a spool-like elongated body **62** having an axial bore in which at least one and preferably a plurality of annular seal rings such as **63** and **64** are positioned. Collar **61** further includes a removable cap **66** which fastens to the body upper end whereby to fixedly clamp the center of canopy **46** to the collar, forming a fluid-tight seal therebetween. The body outer surface is smoothly contoured to permit the flexible canopy when in a collapsed condition, to lay against the body surface when so urged by external water pressure.

When collar **61** is withdrawn to lower or retracted position as shown in FIG. **2**, tank **62** will be in a substantially empty condition. Thus, when tank **26** is submerged beneath the water, external water pressure will urge the canopy inwardly against the inner wall **33** of hull **31**. Under such external pressure, air or other fluids held in the tank storage compartment is compressed through a venting valve or port, which valve incorporates a uniflow arrangement. Sealing connection **43** carried in receptacle **58** may thus be provided with a check valve facility to permit evacuation of the fluid holding compartment during descent of the tank **26** and yet, permit filling of the compartment by way of nozzle **24** when the tank has reached and been coupled to the vessel **12**.

Canopy **46** which when in the expanded position, defines the liquid holding chamber, comprises material embodying both physical flexibility and chemical resistance to deterioration when in contact with crude oil and/or sea water. Although canopy **46** will not be subjected to excessive physical strain, it may nonetheless be fabricated of a reinforced rubber composition such as metallic mesh imbedded into a rubber coated, body forming material.

As presently shown, canopy **46** is peripherally clamped to the rim **44** of hull **31**. A center opening in the circular canopy registers on collar **61** to be sealably clamped thereto.

Operationally, the disclosed liquid transfer tank is adapted for convenient manipulation while at the water's surface and yet is readily engaged to the underwater liquid holding vessel **12**. Thus, the transfer tank is relatively light in weight, further, due to the collapsible nature thereof is readily adapted to being conveyed to an offshore site by barge or helicopter. However, the controllably buoyant hull permits the unit to be floated into place at the well site prior to being submerged for connection to the liquid holding vessel.

At the offshore well site, the tank **26** is submerged by at least partially filling the buoyancy control tanks within the hull **31**. The tank is then controllably submerged through the water either by guidance from a support means connected to hull **56**, or by underwater manipulation.

At the underwater position, the tank is guided and locked into place by cradle **27** fixed to the upper side of vessel **12**. The inwardly flared guide surface of hull **31** permits the tank to be properly positioned as to align nozzle **24** with the receptacle **28** of the tank hull **31**. As nozzle **24** enters the chamber **58** the nozzle becomes sealably connected at a peripheral joint to the tank by coupling **43** whereby to form a fluid-tight passage between the reservoir **12** and the tank storage compartment.

As in the instance of many deep water installations, the pumping system of vessel **12** is automatically or remotely regulated. Thus, with the sealable connection made, a pressurized flow of crude oil held in vessel **12** is pumped through conduit **21** and nozzle **24** into and through radial passages **59**. The pressure under which crude oil leaves pump **16** must be in excess of the external pressure acting on the flexible canopy **46**, whereby the latter as the liquid flow continues, will be

urged outwardly. Thus, with the continued filling of the tank storage compartment, further outward displacement of canopy **46** will cause the collar **61** to be upwardly moved to its advanced condition until abutting the upper end of column **42**.

During the filling operation, the buoyancy of the tank **26** might be regulated through a remote connection whereby to either maintain the tank in submerged condition or lighten the same by evacuating the hull. At such time as the tank is in condition to be raised to the water's surface, the hull is controllably evacuated thereby lessening the load on the lifting means, which action will raise the tank to the water's surface.

Such lifting means may comprise a submarine vehicle adapted to engage the tank **26** while in the water, or may include one or more guidelines extending from a barge at the water's surface downwardly for removable connection to the tank **26**.

With the tank raised to the water's surface, it might be lifted onto a barge for transporting to shore based refinery or in the alternative, floated to the shore point due to the buoyancy of the hull **31**.

Other modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. Lightweight transfer tank for deep water offshore operations, being adapted to convey a liquid cargo from a submerged liquid holding reservoir to the water's surface, which tank includes:

a. a base, including a floatable hull having an inner surface with a peripheral rim;

b. at least one support column having an end fastened at said base and extending normally upward therefrom;

c. a collapsible canopy including an outer edge sealably fixed at said base peripheral rim, and having a central portion;

d. a collar operably received on said at least one column to be longitudinally slidable therealong between advanced and retracted positions; and

whereby, when said collar is urged into the advanced position at said column upper end, the collapsible canopy will be expanded to define with said base inner surface, a fluid holding chamber; and when said collar is at the retracted position, said canopy will be collapsed into engagement with said base inner surface.

2. In a liquid transfer tank as defined in claim **1** wherein; said floatable hull includes means forming a coupling receptacle adapted to sealably engage a filling nozzle communicated with said submerged reservoir of liquid to be transferred.

3. In a lightweight liquid transfer tank as defined in claim **1** wherein; said floatable hull includes; means forming a coupling receptacle in the hull underside, said coupling receptacle including an outer conical guide passage adapted to receive a filling nozzle, and a sealing member in said receptacle adapted to engage a corresponding portion of said filling nozzle to define an annular seal tight joint therewith.

4. In a lightweight liquid transfer tank as defined in claim **1** wherein; said hull includes a flotation system having at least one buoyancy compartment, and pumping means communicated with said at least one compartment for regulating buoyancy of said transfer tank.

5. In a lightweight liquid transfer tank as defined in claim **1** wherein said hull includes a flotation system having a plurality of discrete buoyancy compartments, said compartments being mutually manifolded to a pumping means, said flotation system being operable to controllably regulate the quantity of fluid in said respective compartments whereby to controllably adjust the buoyancy of said transfer tank.

6. In a lightweight liquid transfer tank as defined in claim **1** wherein; said floatable hull includes an outer base plate, an inner wall spaced from said base plate, a plurality of substantially concentric baffles disposed internally of said base plate and wall respectively and being sealably connected thereto to form concentric buoyant chambers therebetween, and a flotation system communicated with said respective discrete chambers including pumping means for controllably regulating the buoyancy of said transfer tank.

7. In a lightweight liquid transfer tank as defined in claim **6** including; radial panels disposed intermediate the respective base plate and inner wall, being fixed thereto to define a plurality of circularly arranged segmented chambers.

8. In a lightweight liquid transfer tank as defined in claim **6** wherein; said pumping means is communicated with the surrounding ocean to transfer water to and from said buoyancy compartments to controllably regulate the buoyancy of said tank.

9. In a lightweight liquid transfer tank as defined in claim **1** wherein; said at least one column is centrally located in said floatable hull.

10. In a lightweight liquid transfer tank as defined in claim **1** wherein; said column includes carrying means at the upper end thereof adapted for engaging a lifting mechanism to raise said tank.

11. In a lightweight liquid transfer tank as defined in claim **1** wherein said collar includes a clamping lip engaging said collapsible canopy, a central passage adapted to register on said column, and means in said passage for slidably engaging the column outer surface thereby to form a substantially fluid tight seal during movement of the collar.

12. In a lightweight liquid transfer tank as defined in claim **1** wherein said collar includes; a plurality of longitudinally spaced seal rings carried in said central passage and slidably engaging said column outer surface to define a sealing annulus.

13. In a lightweight liquid transfer tank as defined in claim **1** wherein; said collapsible canopy is formed of a flexible material.

14. In a lightweight liquid transfer tank as defined in claim **1** wherein said collapsible canopy includes a nonmetallic flexible material having a reinforcing component incorporated therewith.