United States Patent

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[54] SUBMERSIBLE TANKER MOORING SYSTEM

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[52] **U.S. Cl.** ..... **141/284,** 9/8 P, 61/46, 114/230, 137/236

[51] **Int. Cl.** **B63b 27/00**

[58] **Field of Search** ..... 9/8 P; 61/0.5, 46, 46.5; 114/0.5 T, 16 B, 16 C, 230; 137/236, 236 OS; 141/387, 388, 250, 284; 166/0.5, 0.6; 220/85 S

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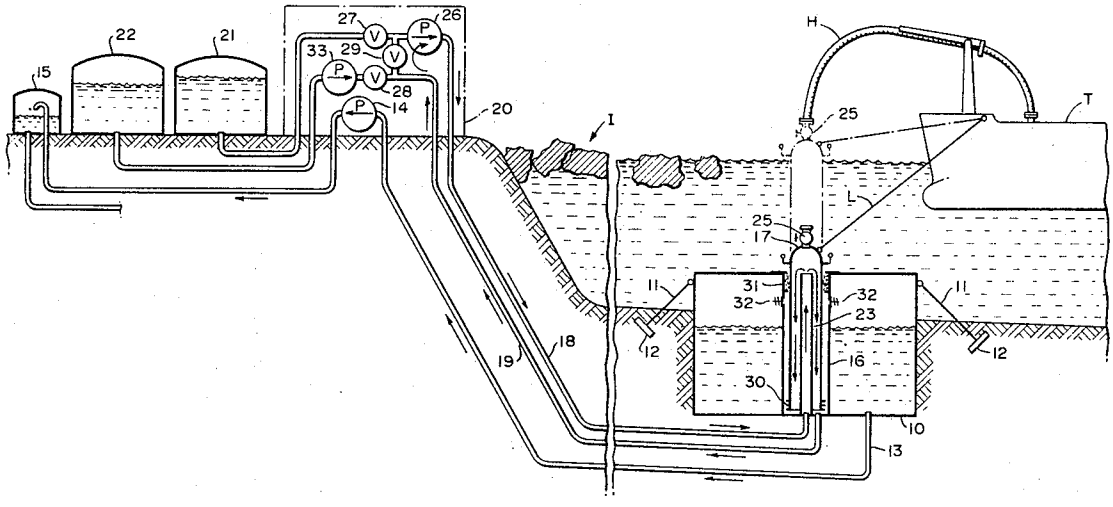
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[57] **ABSTRACT**

A submerged buoy anchored to the sea bottom at depths below surface hazards. A vertically extendable mooring-transfer apparatus defining an accumulator volume, and providing manifold means fitting it as a mooring attachment for tankers and other types of ships, and for connecting to the receiving or delivery pipelines of such ships. Submerged pipelines connecting the extendable apparatus to shore or other supply or receiving points. Means for receiving-delivering oil through said pipes and apparatus and between said ships and shore or other points, and for pressuring said accumulator volume to extend said apparatus to operating position above, at, or near the surface.

15 Claims, 5 Drawing Figures



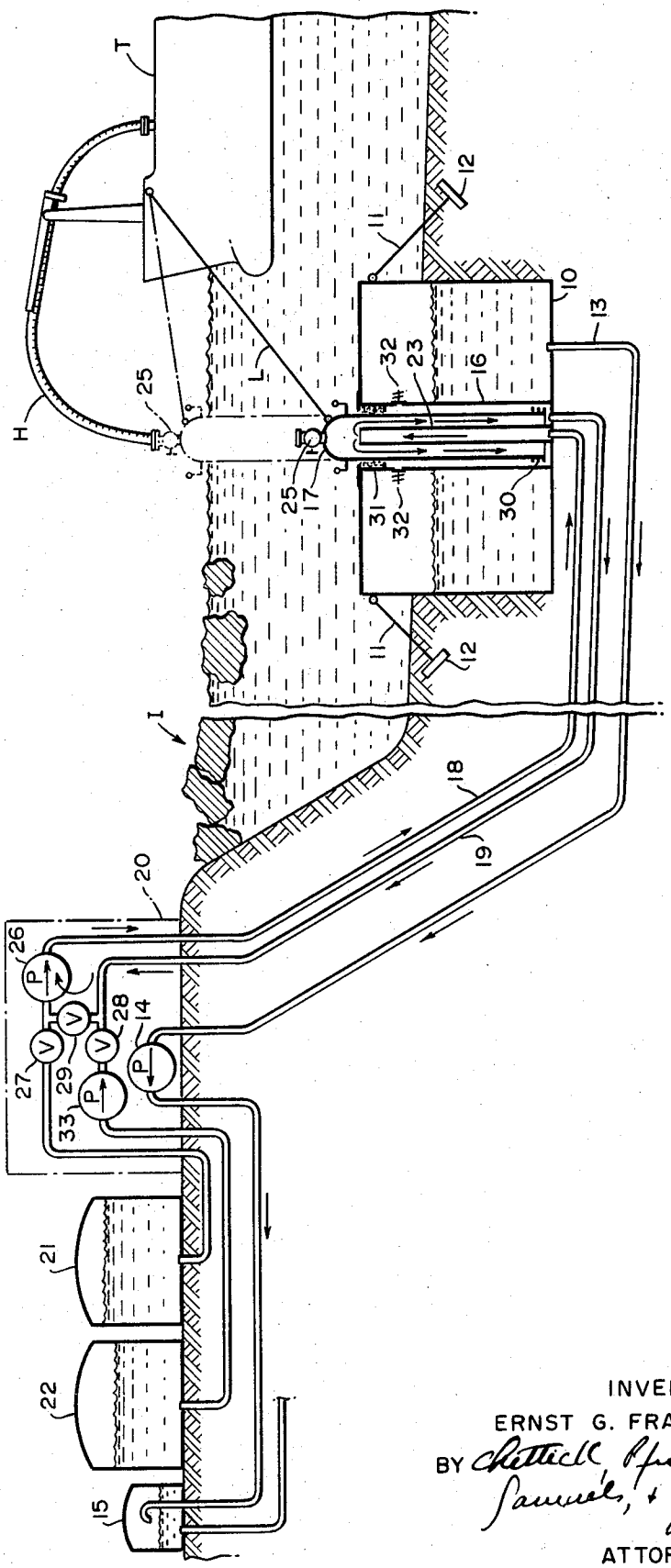


FIG. 1

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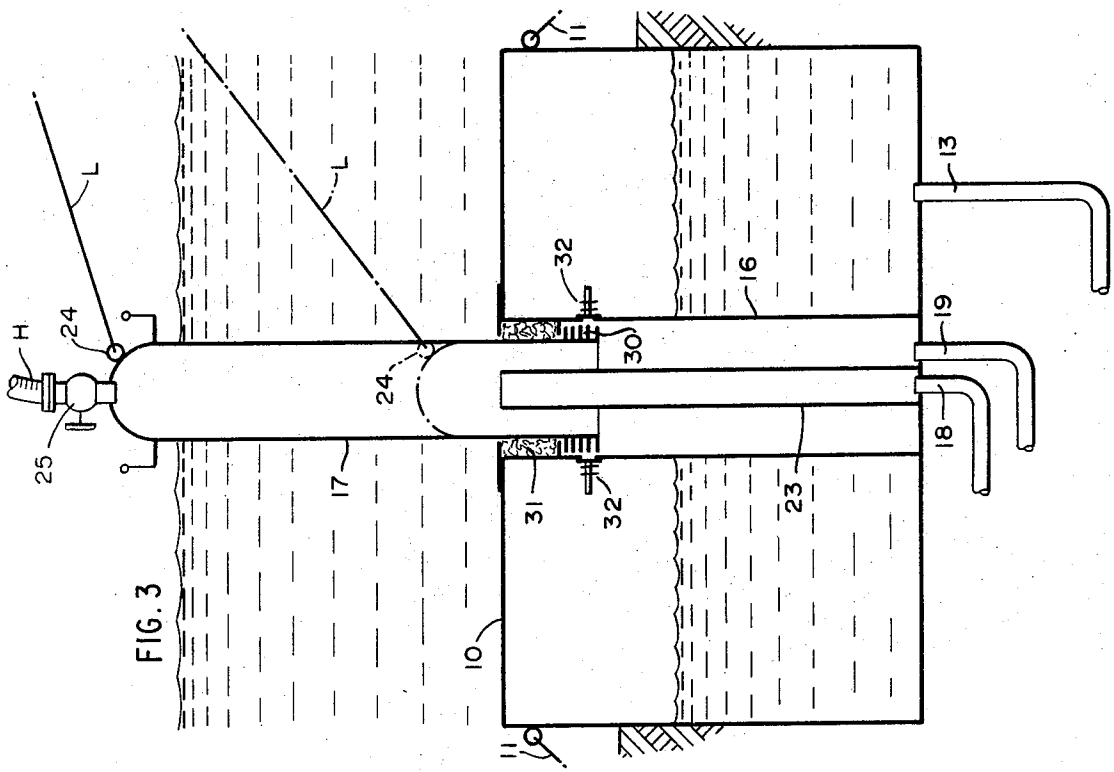


FIG. 3

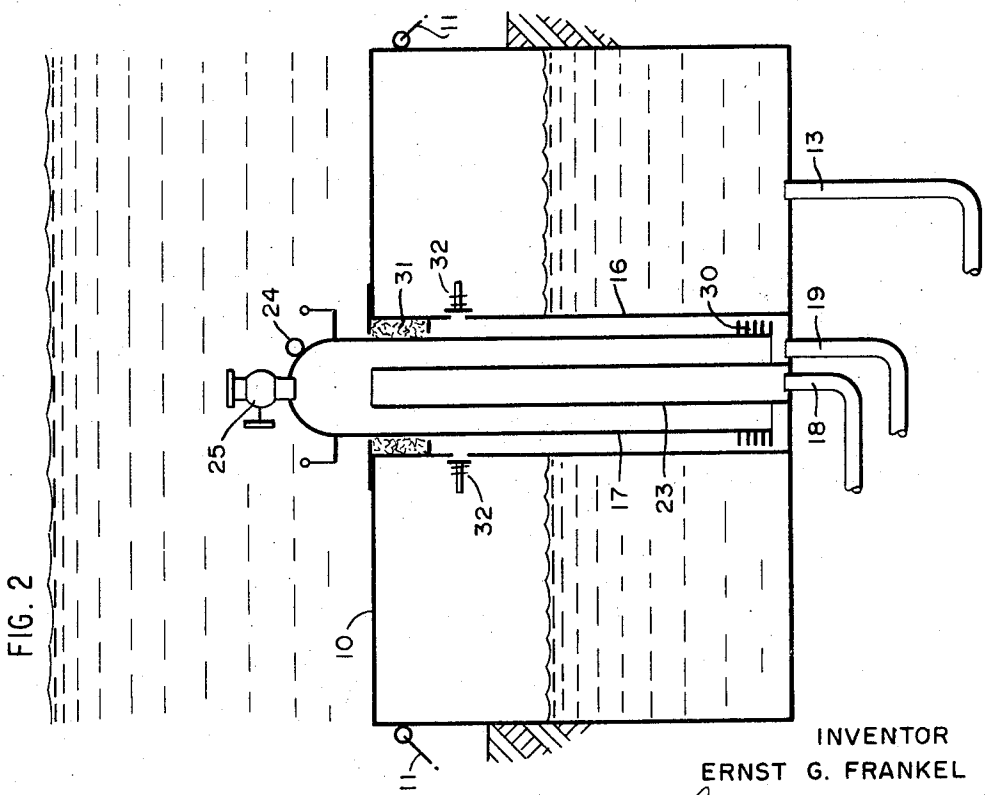


FIG. 2

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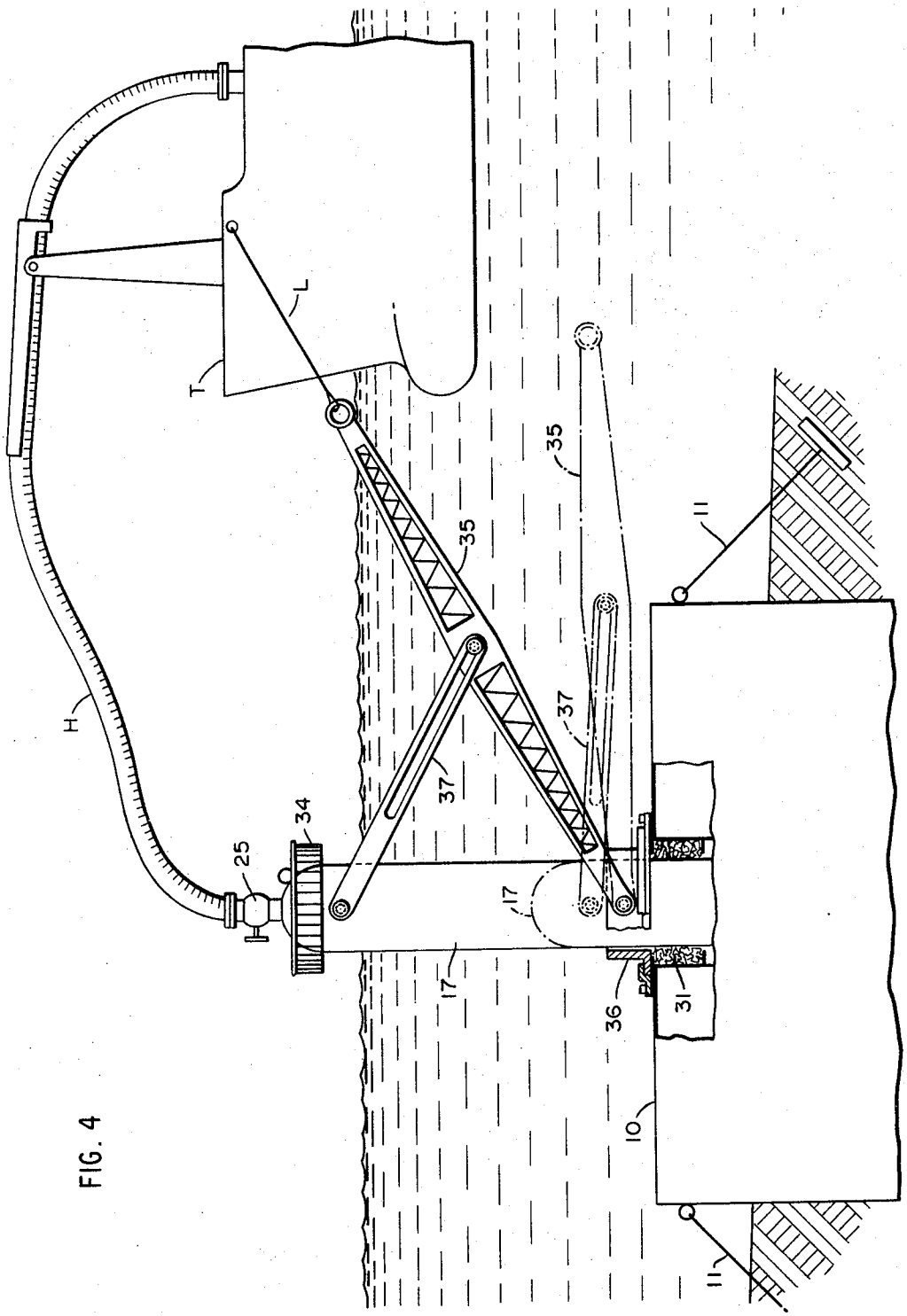


FIG. 4

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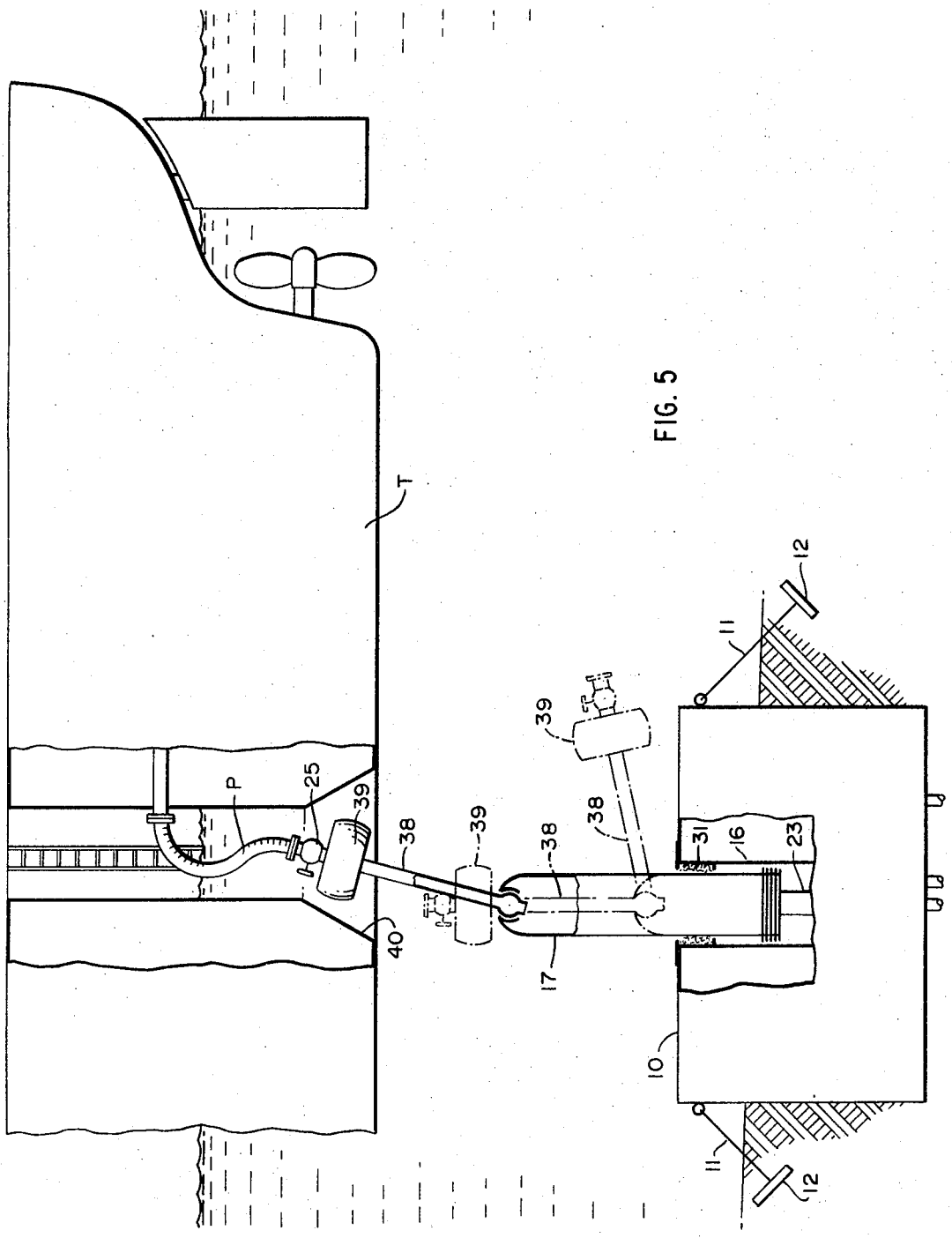


FIG. 5

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SUBMERSIBLE TANKER MOORING SYSTEM

FIELD OF THE INVENTION

This invention relates to deep water mooring systems, providing a fixed buoy rigidly supported on, or a free buoy anchored to, the sea bottom, the buoy adapted for mooring or tying thereto of ships, and also for connection to oil or other receiving or delivery pipelines of such ships.

DESCRIPTION OF THE PRIOR ART

The mooring systems such as here concerned have heretofor comprised, for the most part, single point mooring buoys, of rigidly supported or freely floating, anchored construction. These prior mooring devices are designed for normal or hazard-free surface conditions, and are neither suited to nor adaptable to the arctic or congested waters, or in other locations or situations where are found the hazardous environmental or surface conditions with which this invention is concerned, and under which the apparatus hereof is capable of safely operating.

A major unsolved problem, then, in the movement of oil from the arctic or congested waters is the difficulty of developing an effective method for the berthing of tankers in safe depths of water and the development of an oil transfer system which can safely operate without interference from surface hazards.

Under this invention the problem is solved by providing a retractable mooring and pipe connecting system for mooring and coupling ships floating in water to supply or delivery pipelines. Thus, for tankers in arctic use, the invention provides a submerged platform hydraulically extendable to the surface after the tanker has broken the ice.

BRIEF SUMMARY OF THE INVENTION

This invention provides novelly a retractible or adjustable height apparatus for mooring of and pipe connection to water buoyant ships. The mooring system incorporates a fluid or oil accumulator apparatus, capable of pressure adjustment between retracted position, in which the apparatus is positioned below and clear of ice, ships or other surface hazards, and extended or operative position in which the apparatus is surfaced for connection to ship mooring lines, and pipe lines. The apparatus is capable of swinging with the moored ship, and of various forms and arrangements of mooring and pipe connection.

The deep water mooring system of the invention includes also means for pressuring the oil or fluid within and for the vertical positioning of the accumulator apparatus, by means of connecting and circulating the fluid between the apparatus and storage tanks or other means located on the shore or other receiving and supply points.

The accumulator apparatus comprises, then, a retractable cylinder or other device which, when extended, may project above the water level to be used as a single point moor and/or to connect with various types of wells or receptacles on or attached to ships.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is an assembly view of the invention deep water mooring system;

FIGS. **2** and **3** show the mooring system with the accumulator apparatus thereof in retracted and extended positions;

FIG. **4** shows a modification of the mooring system fitting that with a mooring boom; and

FIG. **5** shows the hose coupling of the system for fluid transfer with a well-type structure whether internal or external to a tanker or the like.

DETAILED DESCRIPTION OF THE INVENTION

The submerged or partially buried, submarine monomoor buoy hereof comprises an accumulator tank **10**, partially imbedded or buried in the sea bottom and rigidly anchored to the ocean floor as by guys **11** and suitable anchoring masses or devices **12**. Under the invention, the monomoor buoy is, in an area of ice I, FIG. **1**, or of other surface congestion or hazards, located at that distance from shore at which it may be in a depth of water in excess of any potential ice ridges, ship draft or other surface hazard.

The accumulator tank **10** may be sufficiently flooded to render it nonbuoyant, and is provided with a bottom opening drain line **13** by which its contained volume may be drawn off, as by pumping means **14**, to atmosphere, or to a disposal unit **15**.

Accumulator tank **10** is interiorly or centrally formed with an annular wall or cylinder **16**, within which the tank is closed at the bottom and open at the top, as shown, FIG. **1**.

The invention monomoor system or structure further comprises an hydraulically extendable element, herein the cylinder or bell **17**, vertically disposed within the cylinder **16**, and having a retracted position of resting or sitting on the bottom of the tank **10**. The bell **17** is permanently connected to the shore or other receiving or supply point by two large submarine pipes, herein the submerged inlet and outlet pipes **18**, **19**, which, in one invention application, may be run through a pumping station **20** to storage tanks **21**, **22** situated on the shore.

Inlet line **18** is shown as terminating within the bell **17** at a delivery or stand pipe **23** extending upwardly from the bottom of the tank **10** to form a baffle or flow separation, as shown by the arrows, FIG. **1**, between the oil supply through pipe **23** and the oil return through pipe **19** opening through the bottom of tank **10** within bell **17**.

Under the invention, the bell or other upper-end-closed cylinder device **17** is adapted to be extended or elevated from the retracted or non-operating position, FIGS. **1** and **2**, to the surface or operating position, FIGS. **3** – **5**, wherein it serves as a single point moor, and/or to connect with various types of wells or receptacles on or attached to ships. For such purpose, the cylinder or other device **17** may have a hemispherical end, or may comprise a multiple ended cruciform or a triangular form, or it may be topped by a buoyancy device; and in any of which forms it may be elevated above the water surface.

In whatever dimension and cross sectional configuration, the device **17** is nonbuoyant, and maintained completely by internal pressure to overcome gravity, friction and water displacement, in its elevating.

In whatever upper-end embodiment, the bell or the like **17** will be understood to comprise a manifold for making pipe connections as well as for securing ship mooring lines.

In the FIGS. **1** – **3** embodiment, the manifold means comprises a ring or other suitable device **24** for anchoring or securing a mooring line L from a tanker T. Diagrammed at **25** is a desired or preferred form of means for removably coupling flexible hose H, or other rigid or flexible hose, whereby oil or the like may be received or delivered through the pipe H, extendable cylinder **17**, and buried supply and return pipes **18**, **19**, as between the tanker T and the tanks **21**, **22** or other receiving or supply points.

In the operation of the FIGS. **1** – **3** system, tanker T locates the submerged monomoor, by sonar or other available means, eliminates surface hazards, in the arctic by breaking the ice I, and positions itself at a safe distance from the surfacing location of the apparatus. The oil in supply and return lines **18**, **19** is then circulated, by actuating suitable pumping means **26**, and with valves **27**, **28** closed and connecting line valve **29** open, to sufficiently warm the oil in the buoy **17**. Valves **27**, **29** are now reversed or opened and closed respectively, and the pumping by pump **26** continued. In this, more particularly, the return pipe **19** is gradually closed to increase the pressure of the oil in the buoy accumulator, which forces the large diameter retractable cylinder **17** upwards.

When the pressure build-up within the bell **17** has climbed or risen to exceed the downward pull of gravity, and to overcome also any frictional resistance to its vertical extending,

the buoy undergoes a controlled, gradual rise to the surface, as shown, FIG. 3. In its vertical extending the bell or buoy cylinder 17 is sealed relative to tank sleeve or well 16 by the labyrinth 30 surrounding the bell bottom and sealing the oil therebelow, and a fixed, tank-mounted gland 31 walling off the sea water thereabove. Upon fluid sufficiently accumulating between the labyrinth and gland 30, 31, as from the open bottom of the bell 17, that may be leaked off to the tank 10 by its opening of the spring closed orifices or check valves 32 or the like venting means, there being less than sea pressure in the accumulator tank 10 by its drain to atmosphere.

It will be appreciated that the pumping may proceed as described from the tank 21, or concurrently or alternately or successively from tank 22, and upon appropriate actuation of the pumps 26, 33, and positioning of the valves 27 – 29. By whatever arrangement there is had the pumping through one, and gradual closing of the other, of the supply and return lines 18, 19, the increase in the pressure of the oil in the accumulator buoy 17 will be to force that to the surface, and more particularly to an upwardly extended position, at which it may be stopped or halted, by guy means or other suitable limit stop devices, and in which more particularly the manifold means 24, 25 are suitably or safely above the level of the water surface.

The invention operation having proceeded as described, i.e., the ship having eliminated surface hazards such as ice, and stationed itself free of the operating position of the apparatus, the buoy 17 will be surfaced as described, and with its manifold means 24, 25 projected above the mean water level, whereupon connection is made as conventionally to the mooring lines L of the ship, and to the flexible pipes H thereof. The ship then starts delivering or receiving oil, with the delivery pumps 26, 33 maintaining the desired or constant delivery pressure, and adjusting to variations. In this, it will be appreciated, the invention system achieves variable flow rates, and submersions of of the top of the monomoor buoy, as desired, by very simple control, and without any manning requirements on the buoy.

Again with respect to the fluid flowing, the initial circulating through the pipes 18, 19 will be at a pressure, say 150 p.s.i., leaving a pressure in the bell 17 not sufficient to raise it. In the ensuing delivery to the tanker, the return line 19 may, of course, be operated as a second filling line, so as to keep the bell up while the tanker is taking on fuel.

For the indicated transfer of oil as between the shore tanks 21, 22 and like tanks or receptacles aboard the tanker T, the pumping will be continued,then, under a pressure calculated to maintain the buoy 17 at the desired extension or elevation. It will be appreciated that, depending upon weather, ice flow, traffic, or environmental and operating conditions, the retractible-extensible buoy apparatus can be maintained in the described surface-condition, or retracted to whatever operating height is desired or required under the conditions obtaining in any given operating situation. In other words, to assure most effective mooring tension under tide or other current conditions, it may be advisable to retract or submerse the hydraulically extendable buoy apparatus from the dash line to or towards the solid line position of FIG. 1, by suitably varying or reducing the accumulator fluid or oil pressure.

For delivery of oil from a tanker T to shore tanks 21, 22 or other receiving point, it will be appreciated that, by suitable control and reverse actuation of the described pumping means, the oil pumped from the tanker into the buoy can then be drawn off as desired, and with continuing control of the pressure to maintain the buoy in the desired operating altitude, or height.

In FIG. 4 are shown certain of the many additional or adaptive features or forms in which the submersible buoy system may be embodied, within the scope of the invention, to meet the particular requirements of a given installation or operating condition. Thus a voided or otherwise buoyant chamber apparatus schematically shown at 34 may be attached in any wise to the top of the cylinder 17, to provide a buoyancy balancing the gravity of the cylinder, and so as to reduce the elevating pressure to that required to overcome friction. Also with the buoyancy assist, the buoy 17 diameter may be made smaller, according to the extensible apparatus greater flexibility in operation. Additionally, a pivotal boom as shown at 35 may be provided, and more particularly mounted on an accumulator-supported, rotating ring 36, and fitted with a swinging arm 37 fixed to, and so as automatically to raise and lower the boom with the extension-retraction of, the telescoping buoy. The boom 35 will be seen to provide a mooring line fastening at a distance from the buoy, and also, by its described bottom anchoring, to relieve the buoy of the bending strain by the vessel's pull on the mooring line.

From the foregoing it will be seen the invention apparatus has the added advantage of being rotatable, eliminating thereby certain of the problems experienced with prior mooring systems, when the direction of surface conditions or winds change, with the consequent change in the position of the moored ship.

In FIG. 5 I show a further adaptation of the apparatus, in which the buoy manifold is fitted with a ball and socket or other universal jointing of the cylinder 17 with a pipe extension 38 fitted with a buoyant ring 39 as well as the valving 25, whereby the same may be fluid coupled through the pipe or flexible hose P to a well-type structure or receptacle internal or external to the tanker T, and having a bottom opening or entrance formation 40, into which the pipe extension 38 may be guided by the buoyant ring 39, upon the pressuring or elevating of the buoy to the FIG. 5 position. Upon completion of the tanker filling or discharging with the FIG. 5 apparatus, it will be seen that upon retraction of the buoy cylinder to the dotted line position, the pipe extension may also be positioned safely below the surface hazards by swinging horizontally from the buoy cylinder, as also shown in dotted line.

Under the invention there may additionally be employed, with the illustrated and other forms of the invention apparatus, various arrangements of retaining cables or ties, such as providing transverse rigidity to the mooring device in extended position, and also providing, if desired, a device for limiting the elevating or extension of the buoy, all as will be readily understood by those skilled in the art.

Within the invention also the topside of the apparatus may be varied, or equipped with various configurations and devices and pipe connections in the form of single or multiple end outlets with manifold valves and rigid or flexible pipe couplings.

I claim:

1. A submersible tanker mooring and oil transfer system comprising:
- a submerged buoy anchored to the sea bottom;
- oil accumulator means associated with said buoy and adapted to be shifted by oil pressure change between submerged and surfaced positions;
- manifold means associated with said accumulator means and adapting that for coupling thereto of tanker oil and mooring lines;
- supply and return pipes for conveying oil between said accumulator means and receiving and supply points; and
- means for circulating oil in said supply and return pipes, for warming that in said accumulator means, for pressuring the oil in said accumulator means to bring that to the surface for mooring and hose coupling of a tanker thereto, and for transfer of oil as between said tanker and said receiving and supply points.

2. The apparatus of claim 1, wherein said submerged buoy comprises:
- a tank, and
- means for securing the tank to the sea bottom.

3. The apparatus of claim 2, and
- a vertically swinging mooring boom rotatably mounted on said tank, and
- means for raising and lowering the boom with the rise and fall of said accumulator means.

4. The apparatus of claim 3, wherein said boom is mounted on

a ring surrounding said accumulator means.

5. The apparatus of claim 2, wherein said tank includes

a cylindrical well.

6. The apparatus of claim 5, wherein said accumulator means comprises

a bell free standing in said well.

7. The apparatus of claim 6, and

a stand pipe within said bell and opening through a bottom wall of said tank, and

said supply and return pipes opening through said tank bottom to the interior of said bell respectively within and without said stand pipe.

8. The apparatus of claim 6, wherein said bell is elevated in said well by oil pressure build-up therewithin, and wherein said bell is sealed in said elevating by means comprising

a labyrinth at the bell bottom, and

a gland at the well top.

9. The apparatus of claim 8, and

valve means opening to said tank from said well to leak off fluid escaping past said sealing means.

10. The apparatus of claim 6, and

a pipe extension carried by said bell and universally jointed thereto for swinging in use with well type ship structure.

11. The apparatus of claim 10, and

a buoyant assist to said pipe extension.

12. The apparatus of claim 2, wherein said tank is adapted to be flooded, and

means for draining said tank.

13. The apparatus of claim 1, and

a buoyant element associated with said accumulator means and offsetting its gravity effect.

14. In an apparatus providing a retractable monomoor and fluid transfer system for ships and operable in arctic and congested waters and under hazardous surface and environmental conditions and circumstances:

a submerged buoy;

means anchoring the buoy to the bottom;

fluid accumulator means associated with said buoy, said accumulator means comprising a rigid, elongated, tubular device arranged for extending-retracting between an operating position in the vicinity of the surface and a nonoperating position of submergence safely below ships, ice, or other surface hazards;

means associated with said buoy for fluid filling of said accumulator device and operable to fluid pressure said device for said extending-retracting of said device between said operating and nonoperating positions and to maintain said device in said operating position; and

means associated with said accumulator means for coupling to mooring and fluid hose lines of ships.

15. A submersible tanker mooring and fluid transfer system comprising:

fluid conduit means adapted to be laid on or embedded in the sea bottom and to be connected both to a shore based pumping and to a shore based receiving station;

submerged accumulator means, said submerged accumulator means comprising

an hydraulically extendable cylinder, said hydraulically extendable cylinder communicating with said fluid conduit means;

manifold means for making connections between said cylinder and ship mooring and pipe lines; and

means for controlling fluid supply and transfer between said fluid conduit means and said cylinder to elevate said cylinder to and maintain it at the ambient surface level.

* * * * *