Nov. 3, 1964 H. G. QUASE 3,155,280

BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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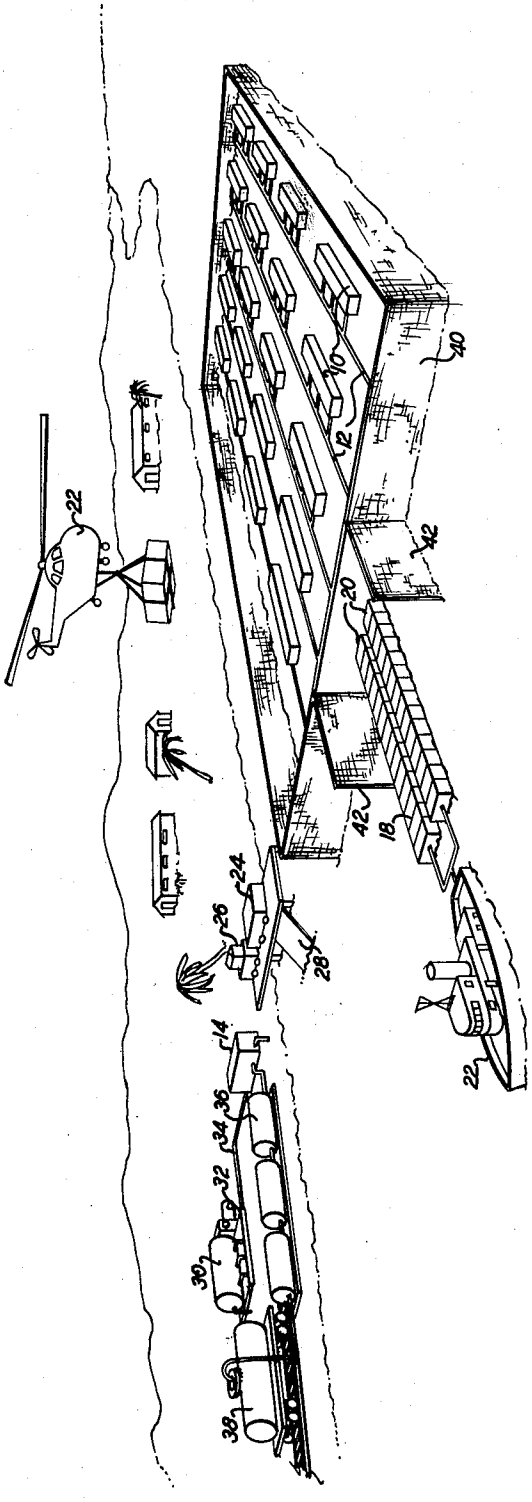
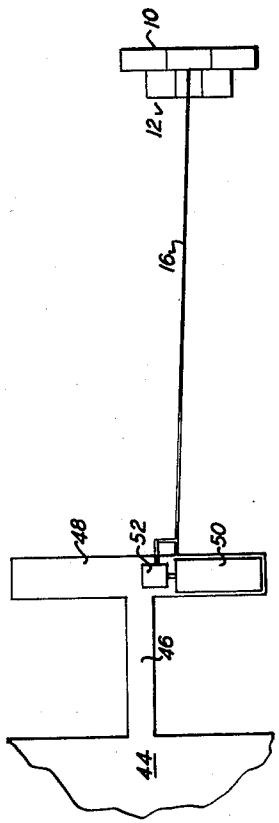


Fig. 1

Fig. 2



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Nov. 3, 1964 H. G. QUASE 3,155,280

BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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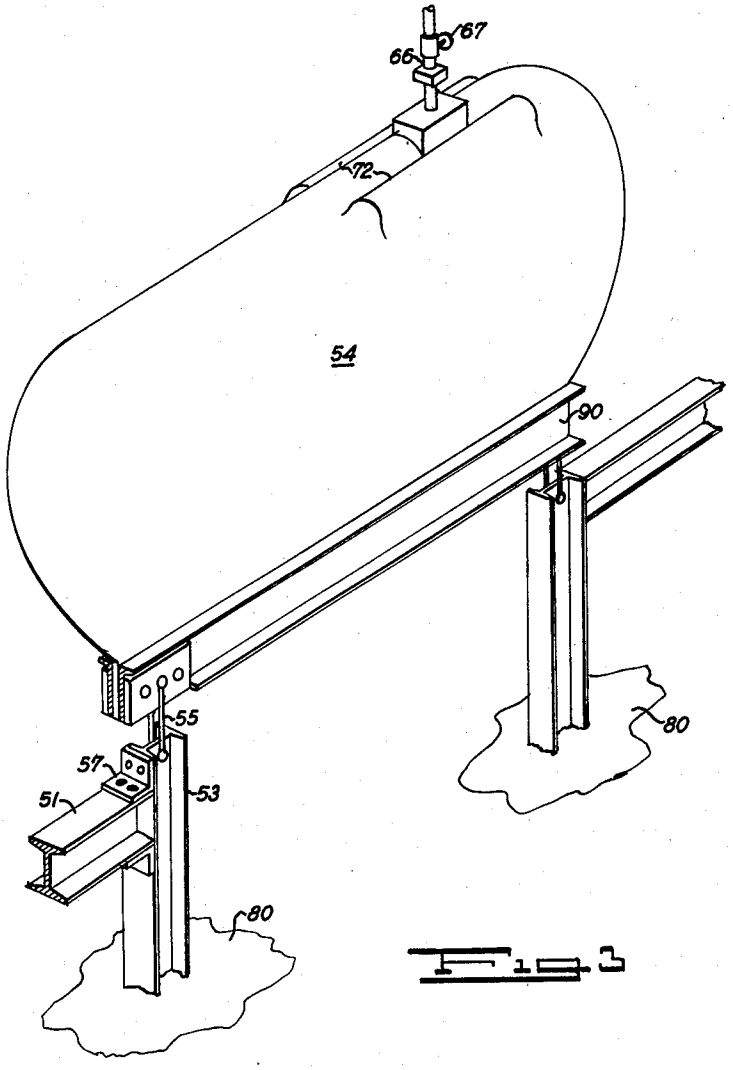

Fig. 3

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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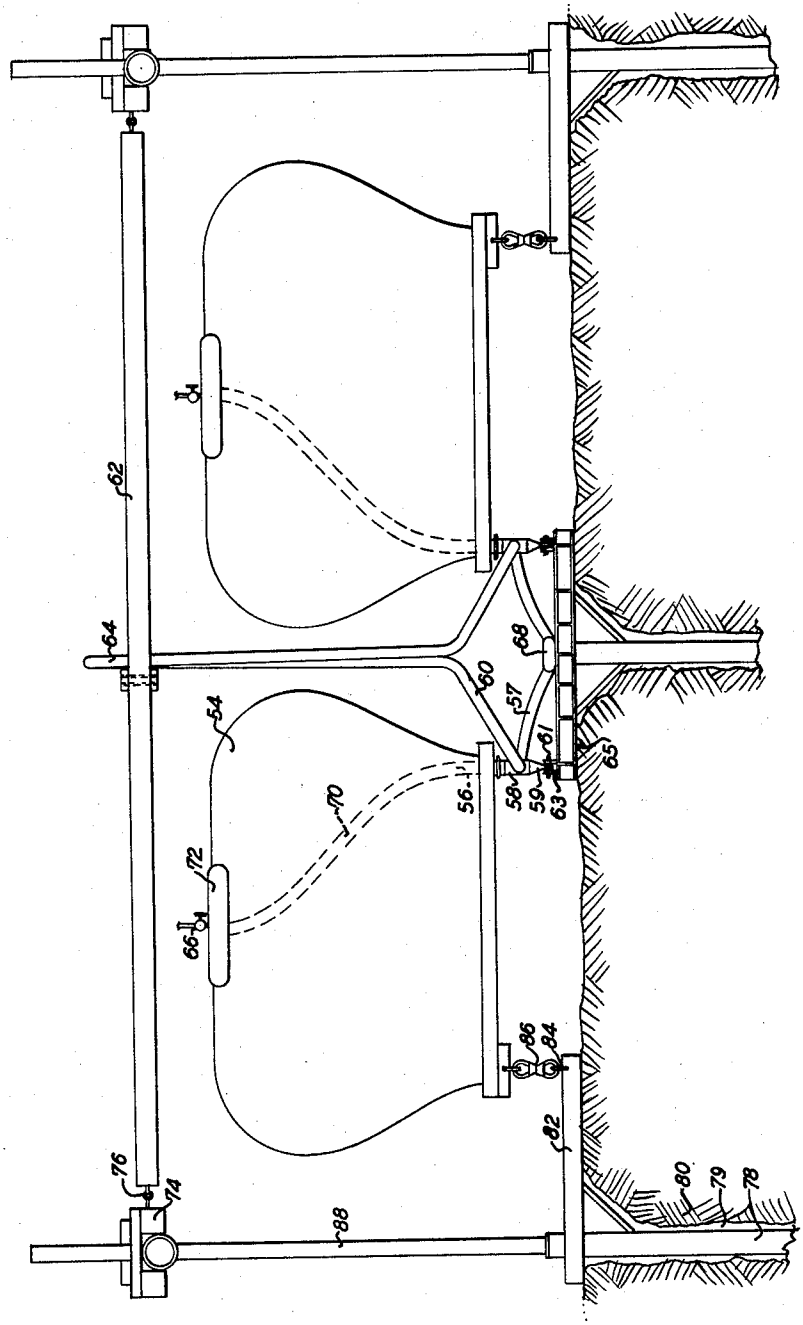

Fig. 4

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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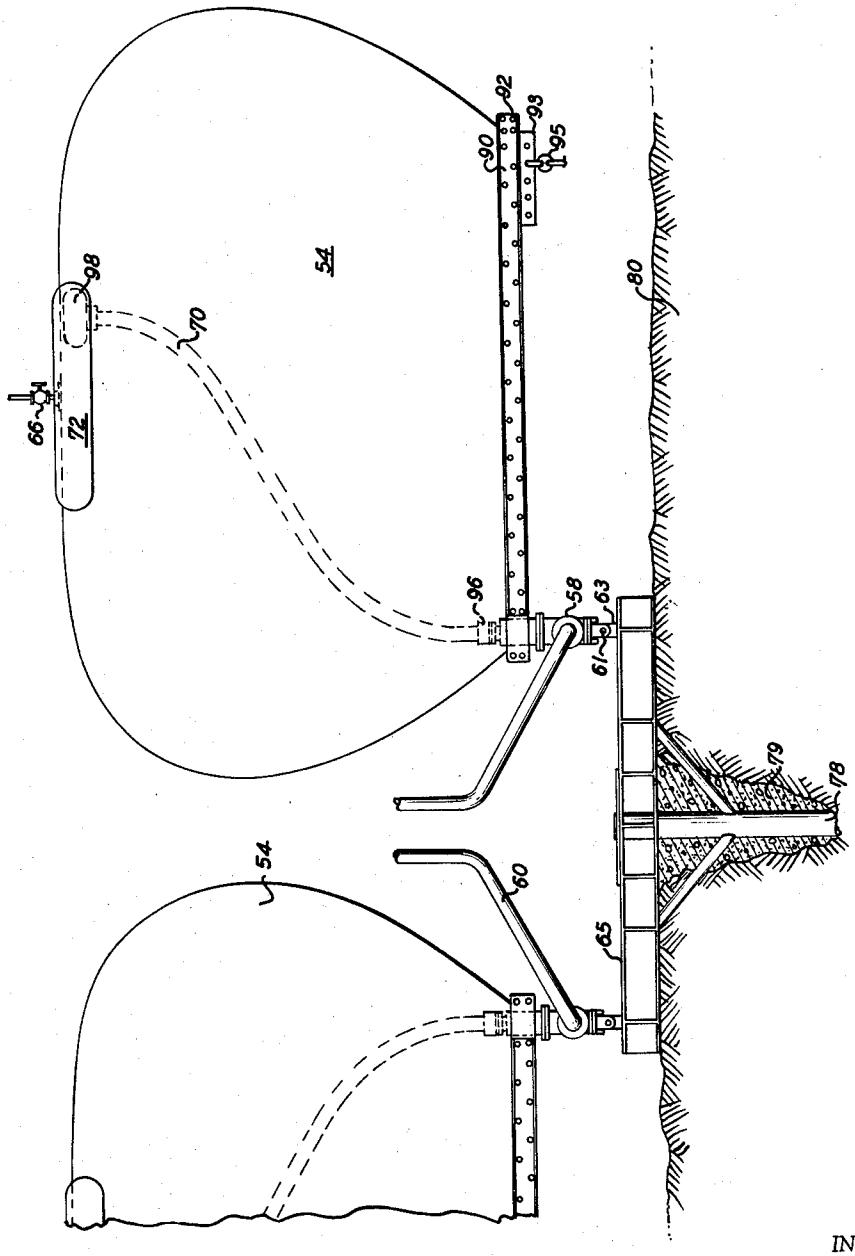

Fig. 5

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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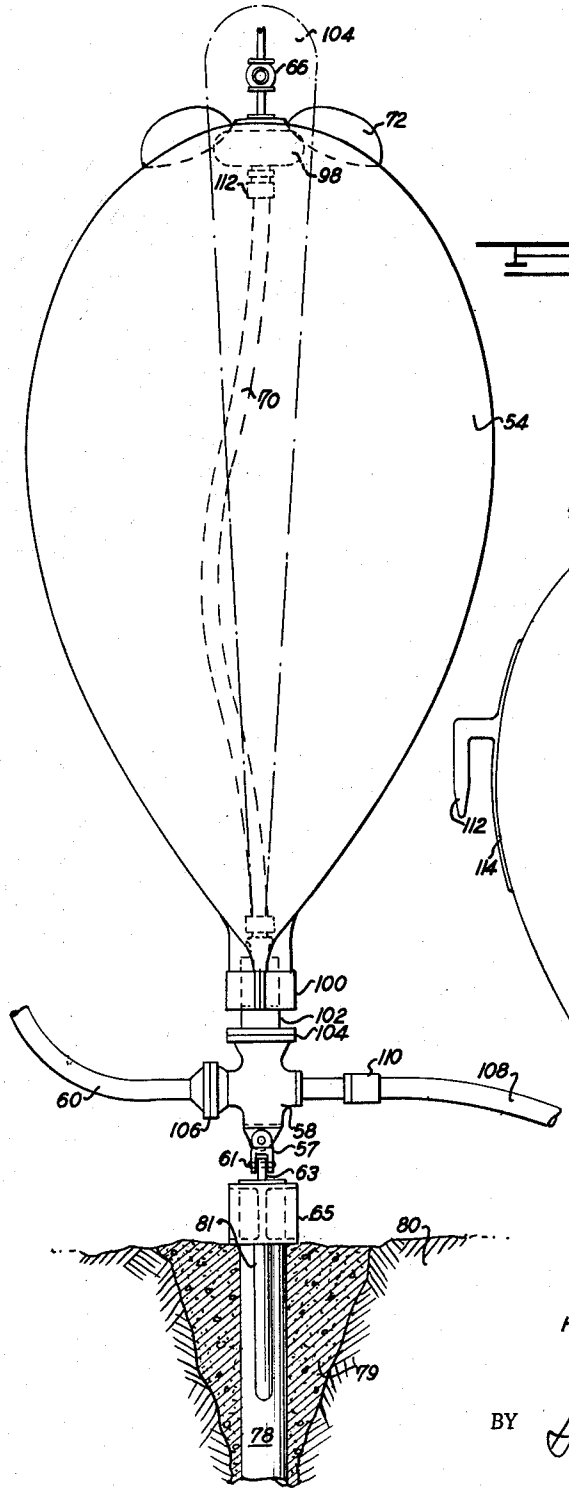
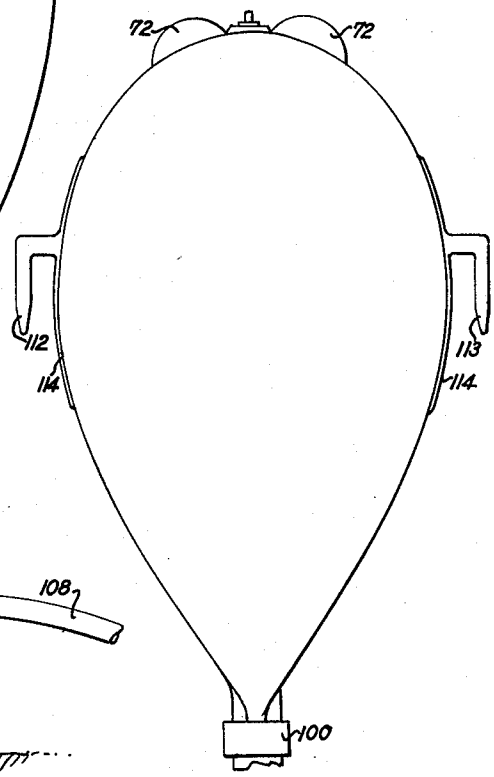


Fig-6

Fig-7



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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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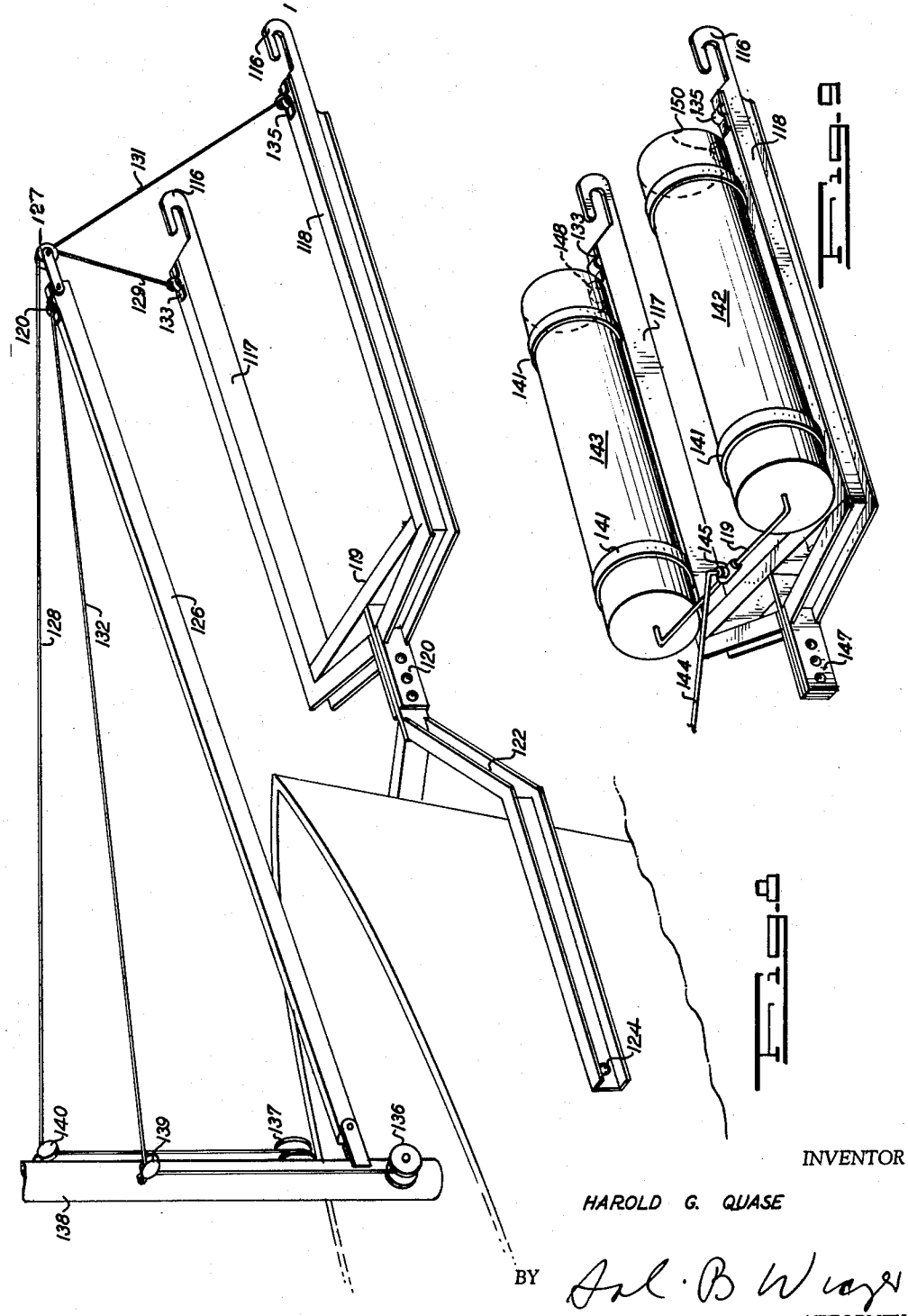

FIG. 5

FIG. 6

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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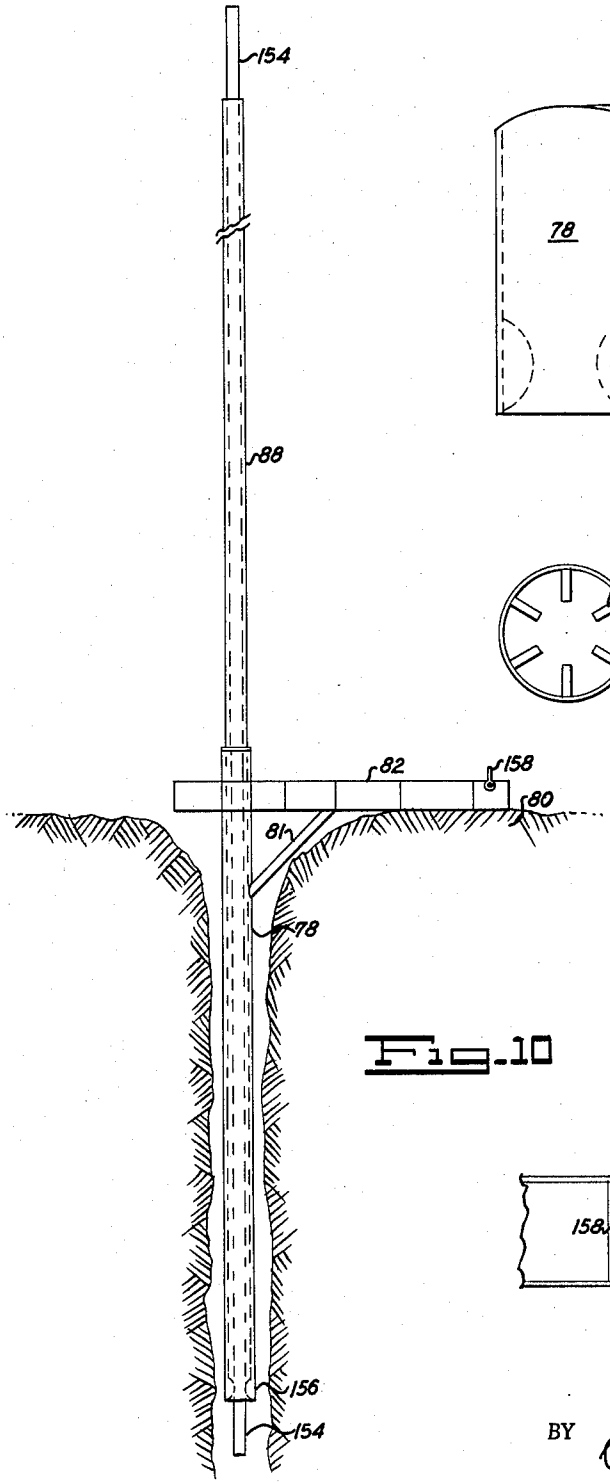

Fig. 10

Fig. 11

Fig. 12

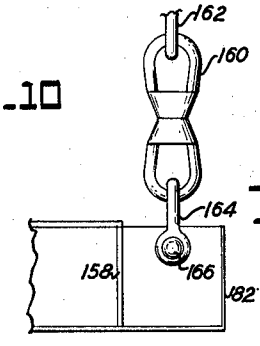

Fig. 13

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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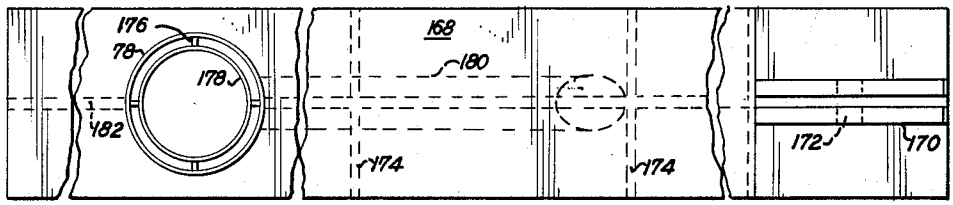

Fig. 14

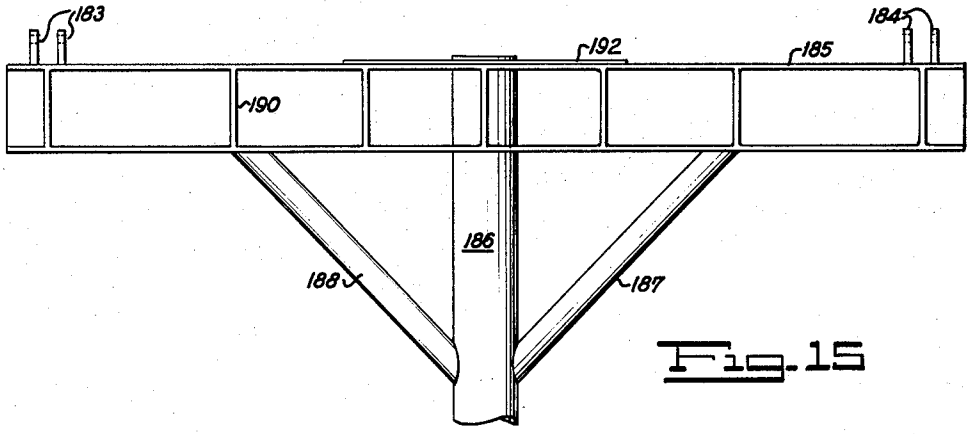

Fig. 15

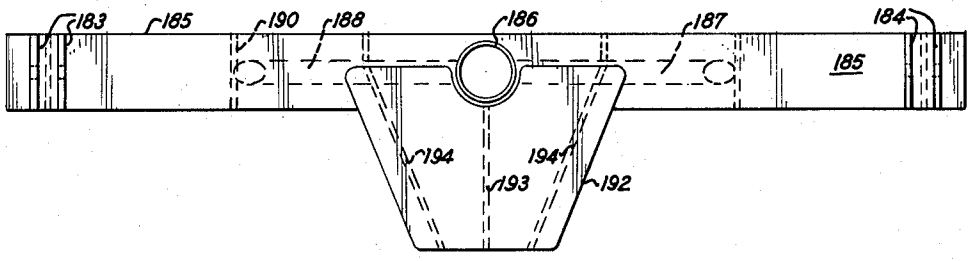

Fig. 16

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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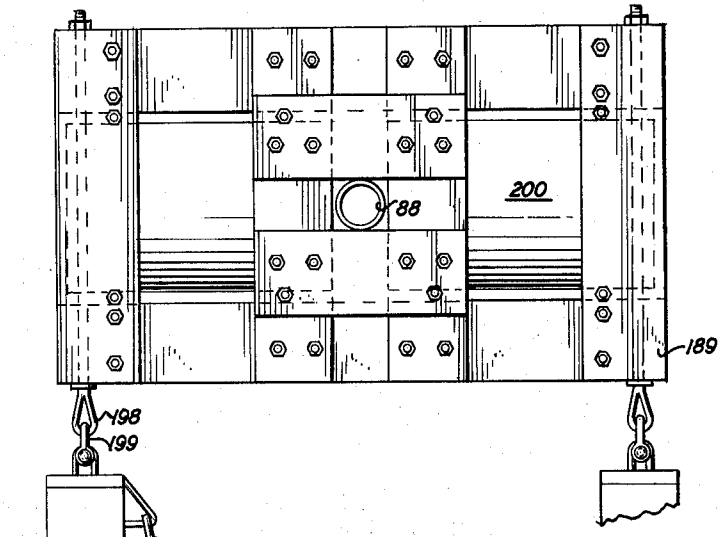

Fig. 18

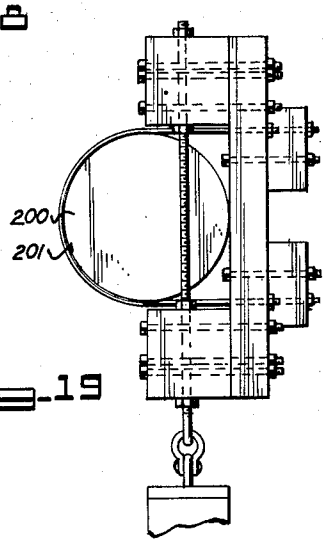

Fig. 19

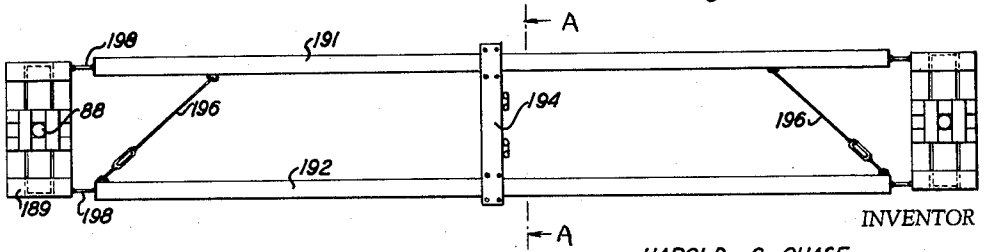

Fig. 17

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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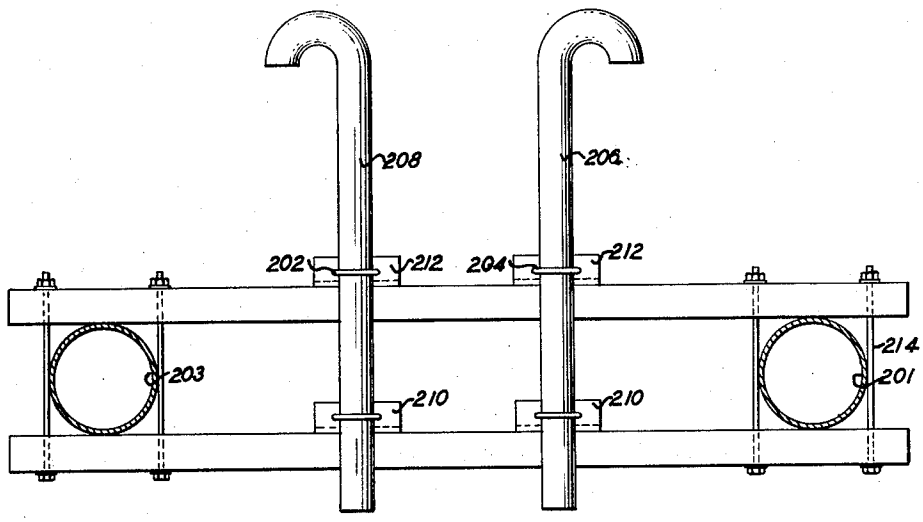

Fig. 20

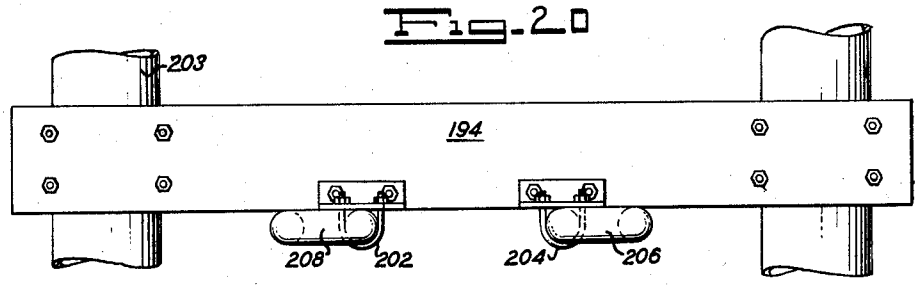

Fig. 21

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BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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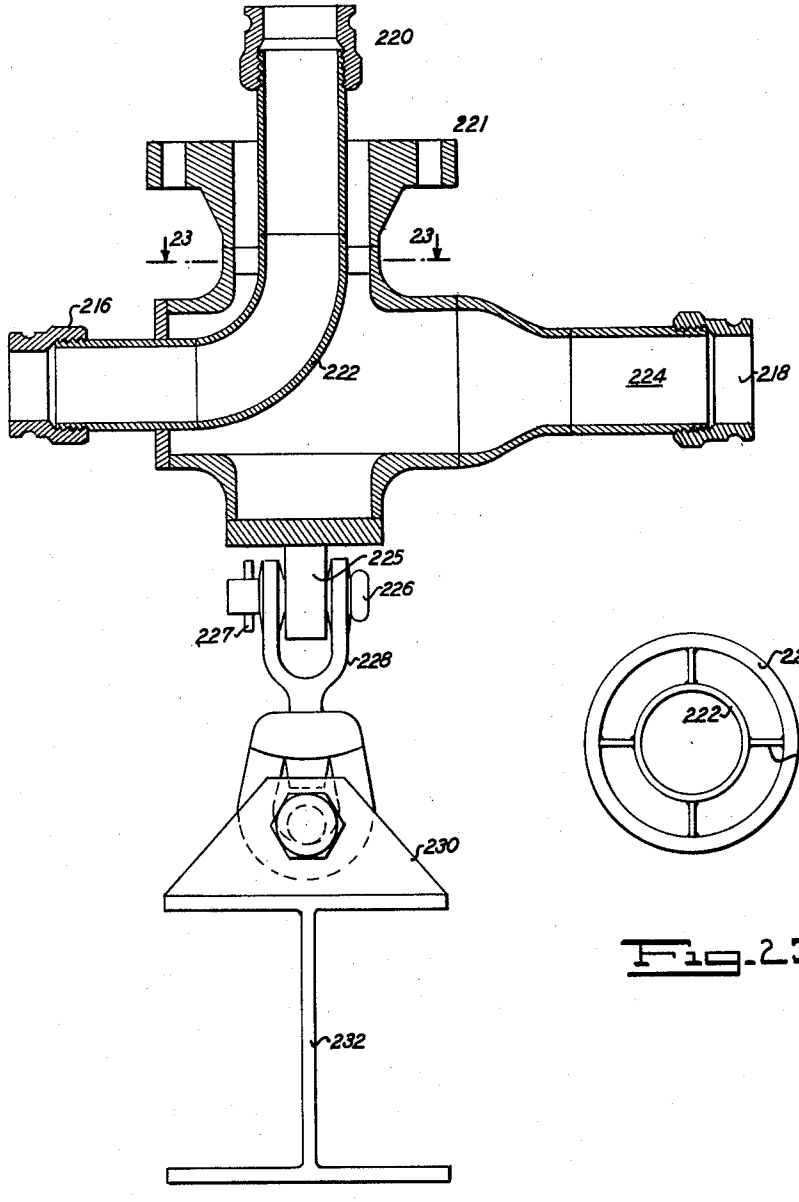

Fig. 22

Fig. 23

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United States Patent Office 3,155,280 Patented Nov. 3, 1964

3,155,280

BUOYANT FLEXIBLE CONTAINER AND UNDERWATER ANCHORAGE THEREFOR

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Filed Sept. 29, 1961, Ser. No. 143,016
13 Claims. (Cl. 222—105)

This invention relates to several improved features of an underwater storage installation. More particularly, the invention includes improved anchoring means for such system at the storage site, improved mounting of collapsible rubber tanks at such site, improved means for filling and venting such collapsible tanks and improved collapsible tank construction including means for handling the collapsible containers.

In my prior copending application Ser. No. 786,434, filed on January 12, 1959, now Patent No. 3,114,384, several new underwater installation assemblies are described including means for anchoring, emplacing and handling underwater containers; particularly with the aid of a cradle or pallet. This invention is an improvement on these features.

An object of the present invention is to provide an underwater storage system which provides both safety and security for storage of liquids of all types, solids transferable by air pressure, and gases.

Another object of the present invention is to use the inherent characteristics of water pressure to aid the container's strength and the cool water temperature to avoid other hazardous conditions. The continuing objects of this invention are to provide improved elastic storage containers of great mobility and versatility, and improved handling and anchoring means therefor.

The containers used herein for underwater storage comprise any waterproof flexible material formed into various shapes and sizes which automatically contract or expand in accordance with the ratio of external and internal pressures. Examples of a waterproof flexible material for use herein are collapsible steel, plastic, rubber, reinforced fabric, and the like.

The storage containers are secured to the bottom of a lake, river, or ocean floor by means of a permanent anchor embedded therein. The type and design of the anchors will vary with water-bottom conditions, size of the storage containers, specific gravity of the stored material and environmental factors. The basic type anchor contemplated by this invention are of the class of anchors grouted in place.

The storage containers may be filled or emptied through attached submerged pipe lines which may be of metal, rubber, or reinforced plastic tubing. Since the underwater system may comprise a plurality of storage units, a manifold system is connected to the main feed line with automatic valves operated by electronic or sonar equipment located either on land or on a floating dock. Such a manifold system may also be manually operated, an operation which may most feasibly be practiced in shallow water.

One of the inherent advantages of the underwater storage containers is their mobility and versatility. Supplies stored underwater can be moved as a unit from place to place simply by detaching the entire storage unit from its anchor and moving and towing it either by natural buoyancy or with a suitable crane or hoist arrangement. To facilitate the mobility and versatility of the storage containers, special grippable flanges, hooks, or arm like members may be attached to the container such that a crane or hoist connectable thereto may lift the entire storage unit or lower it accordingly.

Although not restrictively limited, the storage containers may be used to store liquids as for example fresh water, petroleum fluids, and liquid chemicals as aluminum sulphate, and the like. Solids may also be stored in underwater in the system, solids especially transferable by air pressure as for example, grains, sugar, salts and the like. Furthermore, the underwater storage system may be most advantageously used to store all types of gas, for example, butane, heating fuels, air, chlorine, and the like.

This invention and its several improvements are further described in relation to the drawings in which:

FIG. 1 is a general view of the installation described in detail in application Serial Number 784,434, filed January 12, 1959, of which this application is an improvement;

FIG. 2 is a top plan view of a further detail thereof showing the shore-to-installation submerged line pipe;

FIG. 3 is a general perspective view of an underwater storage container and the anchor arrangement to the water bottom which in part constitutes improved features of the present invention;

FIG. 4 is a longitudinal vertical view of the underwater storage installation of the present invention;

FIG. 5 is a further enlarged view of FIG. 3 showing the features in greater detail;

FIG. 6 is a side elevation view of FIG. 4 while;

FIG. 7 is a side elevation view of a modified form of the present invention featuring grippable side arms;

FIG. 8 is a perspective view of a hoist arrangement used to hoist the storage container by the protruding side arms featured in FIG. 7;

FIG. 9 is a perspective view of an embodiment of the hoist depicted in FIG. 8;

FIG. 10 shows a side view of a corner anchor arrangement secured in the sub-aqua terrafirma;

FIG. 11 is an enlarged detail side elevation view of the spacing members in the casing pipe;

FIG. 12 is a bottom projection view of the casing pipe depicting the arrangement of the spacing members;

FIG. 13 shows a swivel connection clamp used to secure the storage tanks to the base platform;

FIG. 14 is a top view of a corner anchor base beam having a single anchor means;

FIG. 15 is a partial longitudinal elevation view of an anchor base beam having two anchoring means on either end of the beam;

FIG. 16 is a top plane view of same;

FIG. 17 shows a top view of the floating log boom;

FIG. 18 further shows a top enlarged detail of the left end of FIG. 17 secured to the anchored pipe;

FIG. 19 is a right side detail of FIG. 18;

FIG. 20 is a partial side elevation view of the floating log vent support section A—A of FIG. 17;

FIG. 21 is a partial top view thereof;

FIG. 22 is a detailed side elevational view of the valve assembly connected to the anchor beam;

FIG. 23 is a partial cross sectional view 23—23 of the valve feed-exhaust channel system.

FIG. 1 shows generally, in perspective, the prior underwater storage system described in detail in the prior Quase application, where the installation comprises numerous storage tanks **10** composed of any suitable waterproof material for underwater storage, desirably spaced and interconnected by a pipeline network **12**, which may be centrally charged or discharged by a pump **14** through the submerged line **16**. The storage tanks **10** may also be supplied by a variety of transportation means as illustrated, such as by rail, tank, truck, ship or plane.

Smaller interconnectable composite containers **18** may be assembled as buoyant containers of any desired shape and transported to the site above water as floating cargo **20** by a towboat **22** and later submerged. These composite containers **18** may then be linked to the pipeline

network 12 until such time when the containers are renewed.

The composite groups of containers 18 may also be assembled on land and transported to the storage site by helicopter 22 or they may be pushed as wheeled carts 24 by a yard tractor 26 down a ramp 28 into the water. Further, the storage units 10 may be charged by a pump 14 which receives the fuel from an underground pipeline, not shown, or from a tank truck 30 at an unloading dockside 32 by way of line 34. The pump 14 may also be connected to intermediate storage tanks 36 which may be fed by a railroad tanker 38 or by land storage tank 30. The submerged storage containers 10 may be protected from damage due to floating objects, heavy undercurrent, and the like by a protective screen 40.

FIG. 2 shows a general top plan view of an embodiment of the underwater storage system described in detail in the prior application previously identified. The shore installation comprises beach 44, an access ramp 46, a dock 48, an intermediate storage tank 50, and a dock side pump 52 which connects the underwater line pipe 16 with the underwater pipe network 12, and to the storage tanks 10.

FIG. 3 is a general perspective view of the underwater storage tank system including the anchor facilities wherein the storage tank 54 is substituted for the multiple storage tanks 10 of FIG. 1. The storage tank 54 comprises float or buoyancy compartments or bags 72, strategically located to sustain the tank in an upright position. A safety valve 66 is provided which may operate automatically by a rupture of pressure diaphragm or the valve may be manually opened and closed by the valve turn 67. The tank 54 of FIG. 3 may be filled prior to being anchored and completely sealed by the strongback iron 90. No additional connections need be made to the tank. In this case, when new supplies are required, the tank is simply released by cutting the tie down cables 55 to the vertical anchor beam 53. FIG. 3 further shows the use of structural shapes such as I-beams to anchor the storage back of tank 54. Initially a hole is drilled in the rock bottom 80 and the beam 53 is grouted in place. A horizontal beam 51 is attached to the anchor beam 53 by the angle brace 57. The horizontal beam 51 further connects other tanks, similar to 54 in a series configuration.

FIG. 4 is a front elevational view of the underwater storage installation illustrating an improved type of tank 54. The tanks for example, may be formed from an impervious synthetic-coated nylon fabric, the inner coating comprising a compound resistant to the solvent action of the liquid contained, and the outer surface coated with neoprene. The storage tanks 54 are provided with a suitable supply inlet 56 located at or near the base of the storage bag and which is further connected to a combined inlet-outlet assembly 58.

The assembly 58 has a dual tubing arrangement which allows for simultaneous filling the storage tank 54 and removing the air. The air content of the tank being filled may be removed by the vent tubing 60 connected to the assembly 58 which is further connected to a floating log boom 62 on the water surface. The vent tubing outlet 64 has a goose neck design which may act as an air trap. The excess gas in the flexible tank may alternatively be released through a safety pressure valve 66. The pressure valve 66 may be automatic or manually operated such as by valve 67. The storage material feed tube 57 to the inlet-outlet assembly 58 is connected to a manifold connected through duct 68 by which plurality of storage containers may be filled simultaneously. The manifold system 68 is further connected to a submerged line pipe 16 (FIG. 2), and from there to adjacent pump or pumps 52. Metering devices (not shown) to control the rate and quantity of flow to the storage units may be used. The operation of filling or discharging material can be controlled from a remote location. The storage tank 54 further contains a flexible hose or tubing 70 which may be attached to the top of the tank. The flexible tube 70 allows trapped air to flow from the top of the storage tank 54 through the venting tube 60 and out the goose neck 64 into the atmosphere. The waterproof storage tank 54 contains a buoyant bag 72 located at or near the top of the storage tank 54 such that the tank will remain upright at all times.

Anchors for the storage tanks 54 are designed to provide adequate support varying with bottom conditions, sizes of the storage containers, specific gravity of the stored material and environmental factors. As shown in FIG. 3 an embedded structural shape 53 may be used to anchor the tanks, or alternately a heavy pipe 78 of FIG. 4 may be used. The pipe anchor 78 may be firmly held in a cavity filled with grout 79. The storage units 54 may now be tied to the base anchor 82 by anchor log 84 secured to the river floor base beam 82 by a swivel clamp 86. The storage tank 54 may also be secured to the anchored base beam by the combination inlet-outlet assembly 58 having a tapered end 59 held by pin 61 to the anchor log 63 further attached to the bed platform 65. The line pipe 88 holds the floating log boom 62 within bounds, and may further hold the protective screen 40 (FIG. 1) in place. The log boom 62 may comprise floating logs, metal tanks, and the like. A plurality of floating log booms may be employed as a base platform for a floating service station, pump house, or attendant's quarters. The floating log boom 62 is attached to a rigging platform 74 by a swivel hook 76. The arrangement permits the log boom 62 to float on the water surface.

FIG. 5 shows an enlarged sectional view of FIG. 4 and discloses how the storage tanks 54 may be fastened at the base by two angle irons 90 fastened together by rivets 92 and further attached to a lug plate 93 and clamp 95. A standpipe cross assembly 58 provides both inlet and outlet channels to feed the stored fluid and bleed the exhaust air simultaneously. The exhaust air vent 60 is attached by the coupling 96 to the flexible hose 70, further attached to an air filter 98. Buoyance bags 72 may be used as aids in keeping the storage container 54 upright in the water.

FIG. 6 shows a side elevational view of the storage container 54 from the side nearer the standpipe supply-exhaust assembly 58 (FIG. 5). A metal band 100 firmly holds the container to the standpipe material inlet tube 102. The standpipe 102 is connected to the supply-exhaust assembly 58 by the flange seal 104. The assembly 58 is further attached to the anchored beam 65 by the swivel hinge 57 and the removable pin 61. The beam 65 is welded directly to the anchor pipe 78 and reinforced by standard pipe 81. The supply-exhaust assembly 58 comprises an exhaust vent tube 60 connected to the assembly 58 by the coupling 106. The feed supply enters the storage bag 54 via pipe line 108. The pressure connection couple 110 on feed hose 108 easily permits a union to be made with the standpipe assembly 58.

FIG. 7 illustrates in partial side elevation view, a modified form of the present invention featuring side hooks 112 and 113 firmly attached to the storage container 54 by a reinforcing strip 114. The side hooks 112 and 113 are used to give mobility to the underwater storage containers 54, with which they may be readily lowered or lifted in the water by a crane or hoist.

FIG. 8 illustrates in perspective, a ship hoist used to lift the supply containing tank 54 of FIG. 7 by the side hooks 112 and 113. The lift hoist comprises a pan of notched grips 116 cut from angle iron arms 117 and 118, and reinforced by a transverse member I beam 119. Detachable bolts 120 hold the hoist to the ship-attached member 122 which is connected to the ship by a pin 124. A crane boom 126 extends a hoist cable 128 to the cutout grips 116. The crane boom 126 further comprises a pulley 127 for the hoist cable 128, and a stationary eye hook

130 for the boom cable 132. The hoist cable 128 divides into sections 129 and 131 which are fastened to the clamps 133 and 135 at the angle iron arms 117 and 118. The windlasses 136 and 137 are used to lift the arms 117, 118 and the boom 126 respectively. A pole 138 is used to support the windlasses 136 and 137 and their respective pulleys 139 and 140.

FIG. 9 is a perspective view of an embodiment of hoist depicted in FIG. 8 which discloses additional lifting tanks 142 and 143 secured to the angle iron arms 117 and 118 (FIG. 8) by metal straps 141. The lifting tanks 142 may be filled with water initially and allowed to sink to the area of the storage containers 54. Air is then pumped into the tanks through the air hose 144. A T 145 permits the tanks 142 and 143 to fill simultaneously as the air enters the tanks. Water is forced out of tanks 142 and 143 through the valves 148 and 150 resulting in added lifting force to the hoist. The coupling plate 147 may readily be secured to the ship attached member 122 with removable bolts. Eye hooks 133 and 135 are connected to the cables 129 and 131 (FIG. 8) and operated as previously described.

FIG. 10 is a side elevation of a corner anchor emplacement in the river bottom. The casing pipe 78 centrally holds the drill pipe 154 by the centering studs 156. The casing pipe 78 is firmly attached to a beam support base anchor 82 having hook 158 for attachment to the storage container 54 of FIG. 6. A reinforcement pipe 81 is angularly welded to the casing pipe 78 and the anchor beam 82 for additional support. A smaller and more economical line pipe 88 may be inserted in the casing pipe 78 for connection to the log boom floating on the water surface.

FIG. 11 is an enlarged detail view of the spacing members 156 in the casing pipe 78 while FIG. 12 further shows a bottom projection thereof. The spacing members 156 may preferentially be of the same material as the casing pipe 78 and fastened thereto by any suitable means as for example, spot welding.

FIG. 13 shows a swivel connection clamp 160 used to hold the storage tanks 54 of FIG. 5 by a fastening 162. The base beam 82 may be formed such to hold an eye loop 164 by the pin 166. A reinforcing plate 158 may be added for additional strength in the beam.

FIG. 14 shows a top view of a corner anchor base beam 168 having an anchoring means 170 for insertion of a holding pin, not shown, through opening 172. The anchor beam 168, reinforced by transverse plates 174, may be welded to the casing pipe 78 of FIG. 10. The holding studs 176 may further hold the line pipe 178 attached to the log boom floating on the water surface. A reinforcing tube 180 is welded to connect the casing pipe 78 and the base beam 168. A further bar 182 may also be used on the adjacent side of the pipe 78 for additional support.

FIG. 15 represents a partial elevation of an anchor base beam having two anchoring means 183 and 184 for supporting two storage tanks similar to the tank 54 of FIG. 3, while FIG. 16 is a top plan view thereof. Basically, the center anchor beam is the same as that of FIG. 14 with the addition of a second anchor means 183. The base beam 185 is securely attached to the pipe 186 with angular reinforcing bars 187 and 188 inserted for additional strength. A plate 192 supported by ribs 193 and 194 may act as a base for the manifold system 63 shown in FIG. 4. Additional plates 190 may be welded to the beam 185 to prevent buckling or warping. The plates 190 will also increase the support strength of the anchor beam 185.

FIG. 17 is a top view of the floating log boom previously described in connection with FIG. 4. The log boom comprises a floating section, transverse members 191 and 192, and a stationary section 189. The two sections are connected by an eye-hook arrangement 198. The stationary platform 189 is firmly secured to the line pipe 88 which joins the casing pipe in the water bottom. A tension rod 196 may be used as a support member on either end of the floating members 191 and 192. Centrally located on the floating member may be used as a support member on either end of the floating members 191 and 192. Centrally located on the floating member may be a vent support 194 to be described in detail with FIG. 20.

FIGS. 18 and 19 represent the stationary platform 189 from a top and side view respectively consisting of wooden planks bolted together and attached to a floating drum 200 by the U bolt 201. An eye bolt 198 is connected by the clamp 199 to provide a lose connection between the stationary platform and the floating boom. The entire platform 189 is firmly held to the line pipe 88 anchored to the water bottom.

FIGS. 20 and 21 represent partial side and top view of the floating log vent support which may comprise floating tube members 201 and 203 connected together by transverse beams 194. The transverse beams are bolted to buoyant tubes 201 and 203 by extension bolts 214. The venting tubes 206 and 208 attached to the storage container 54 of FIG. 4 located on the water bottom, are held to the transverse beams 194 by angle plates 210 and 212 and the U bolts 202 and 204.

FIG. 22 relates to the valve assembly connection to the anchor beam which FIG. 23 represents a partial sectional view 23—23 of the valve assembly feed-exhaust channel system. Basically the assembly comprises an inlet feed channel 224 through which the stored materials may pass either into or out of the storage tank 54. The second channel 222 allows trapped air to be withdrawn as the storage tank is filled. As shown by FIG. 22, all valve connections 216, 218, and 220 may be pressure fitted. The spacing flanges 223 of FIG. 23 centrally support the internal channel 222. The valve assembly is bolted to the storage tank by bolt holes 221. A metal lug 225 may be welded to the bottom of the assembly where the stirrup bolt 228 is held by a removable stud bolt 226 and the cotter pin 227.

I claim:

1. An underwater storage anchorage comprising a pair of anchoring members horizontally spaced from each other at the anchoring site under water, each anchoring member comprising a vertical support beam and a horizontal support beam, the vertical support beam being embedded in the underwater bottom at the storage site and fixed in concrete, each horizontal beam connected to its vertical support beam extending alignedly towards the horizontal beam of the other and each horizontal beam having means at the extremity thereof remote from the vertical beam for anchoring and supporting a portion of a buoyant container between them at the underwater site.

2. The anchorage defined in claim 1 wherein the means for anchoring and supporting a buoyant container comprises a shackle bolt.

3. The anchorage defined in claim 1 wherein the means for anchoring and supporting the buoyant container comprises a tie-down cable extending between the container and said horizontal beam.

4. A container for underwater storage comprising a flexible bag elongated in a horizontal direction and faired at each end and having an expanded and rounded upper portion the combined upper and lower bag contours tapering at its sides to a narrow neck at the lower portion approximating a pear-shape in cross section, the edges of only the lower portion being sealed together in a bracketing beam at the bottom.

5. Underwater storage container as defined in claim 4 having buoyancy bags along the upper surfaces maintaining the expanded upper container portion buoyantly vertical.

6. Underwater container comprising a flexible bag elongated in a horizontal direction and of continuous flexible walls flaring and rounded at the top continuing

downward into integrally joined sides and sealed at the bottom by a rigid beam closure member, gas bags adjoining the flared top of said container body opposite to said beam closure supporting said bag buoyantly vertical.

7. The underwater container defined in claim 6 having venting means for supply and removal of air from the upper portion of said container and independent filling and discharge means passing to and from said container bottom for supply and removal of fluid substances to be stored in said container.

8. Underwater storage anchorage comprising a pair of anchoring members horizontally spaced from each other at the anchoring site under water, each anchoring member including a horizontal supporting beam, each horizontal support beam extending toward the horizontal supporting beam of a similar neighboring anchoring member, a flexible container flared and rounded at the top continuing downward into integrally joined and sealed by a horizontally elongated beam closure at the bottom, means for maintaining said container vertically upright and shackling members at each end of said sealing beam to the rear end of one of the neighboring horizontal support beams whereby to support said container between neighboring pairs of horizontal supporting beams.

9. The system defined in claim 8 wherein each container has means for venting air therein to the atmosphere and means for supplying and withdrawing fluid materials to be stored in said container.

10. A flexible container for storage of fluid materials under water, said container being horizontally elongated, faired at each end, bulging laterally at the top with sides tapering to an edge at the bottom as to be substantially pear shaped in cross section, the bottom edge being sealed in a sealing beam, shackle means for securing said beam at each end and to anchoring members under water, said shackle means including duct means combined to supply both vent gases and fluids for storage independently to and from said container.

11. The container as defined in claim 10 having gas pockets along the top providing a buoyancy whereby the container is constrained to float upright with the sealing beam at the bottom.

12. The container defined in claim 10 having bracketing ears protruding from its sides cooperative with a lifting fork for removal of the container from the water.

13. A container as defined in claim 4 in which said bracketing beam consists of two elongated structural shapes, each shape having a vertical web bearing against each lower edge of said container, and clampingly sealing said edges together as a closure for said container.

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