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3,008,599

OFFSHORE CRUDE OIL LEASE TANK BATTERY

Filed June 19, 1958

2 Sheets-Sheet 1

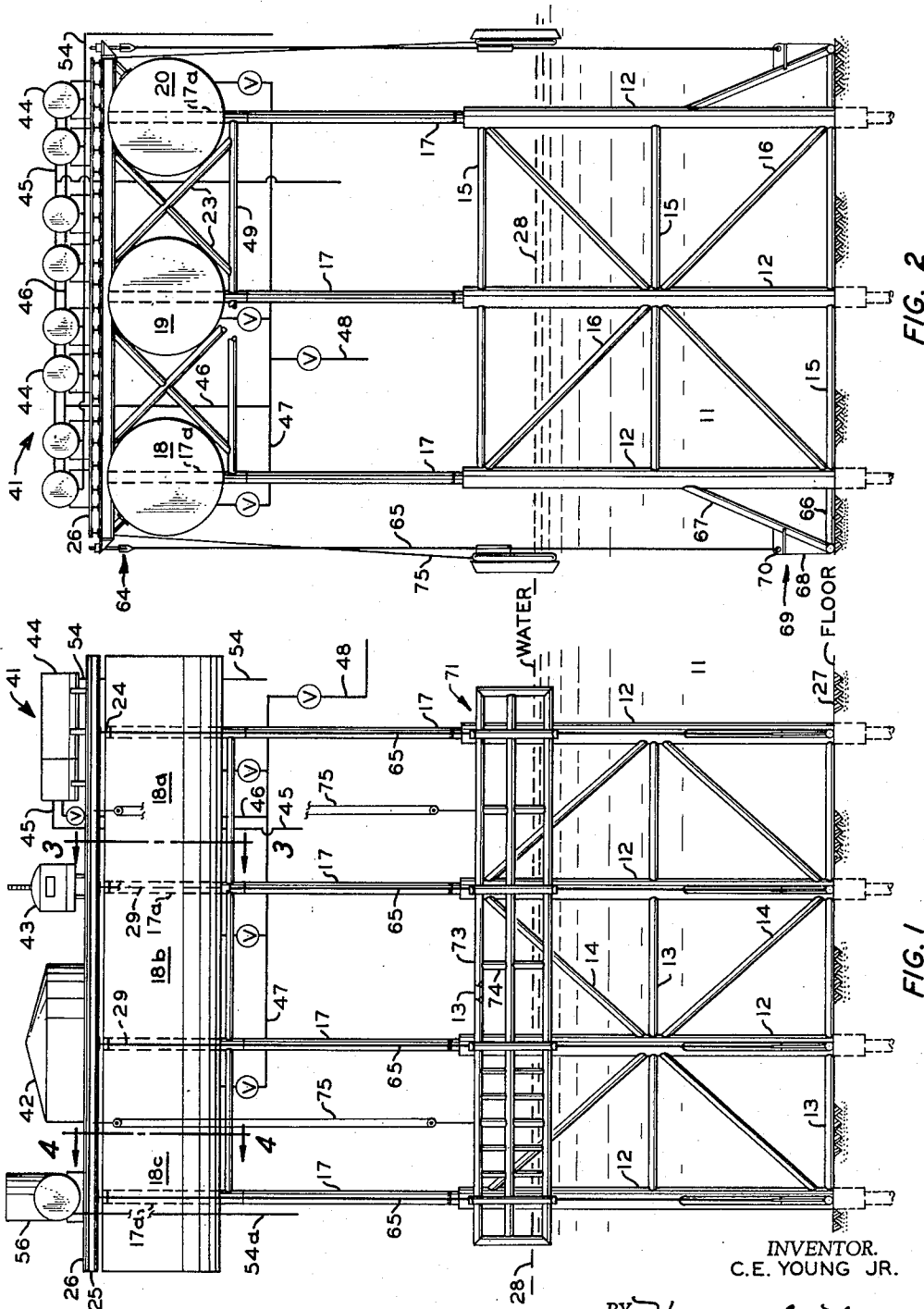


FIG. 2

FIG. 1

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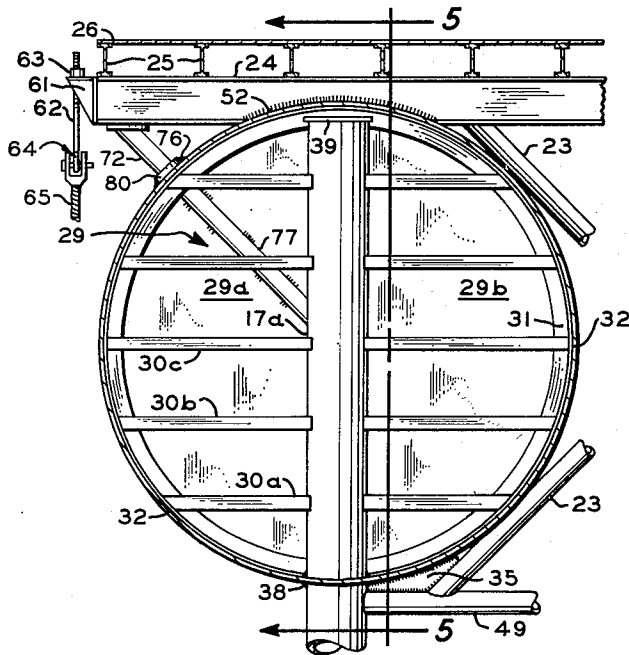


FIG. 3

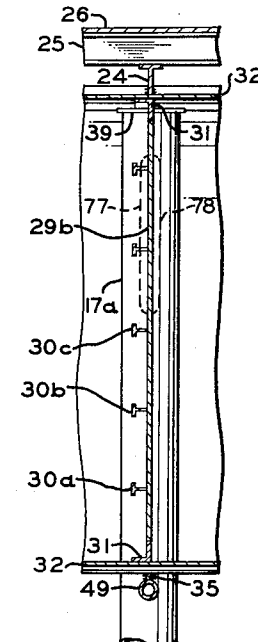


FIG. 5

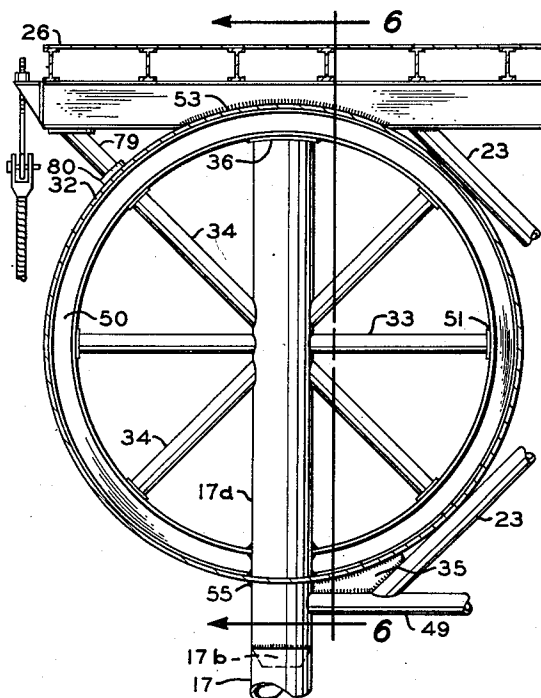


FIG. 4

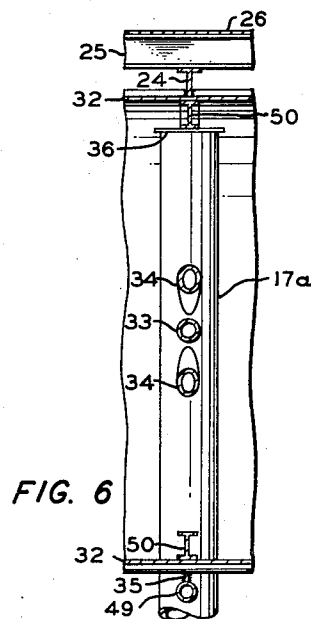


FIG. 6

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OFFSHORE CRUDE OIL LEASE TANK BATTERY

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12 Claims. (Cl. 220—1)

This invention relates to an offshore tank battery for handling crude oil. In one aspect it relates to an offshore tank battery for handling crude oil wherein the entire platform area is available for the auxiliary crude oil handling and processing equipment. In another aspect it relates to an offshore tank battery system in which the treated crude oil storage tanks are disposed below the working platform.

Offshore tank batteries are ordinarily placed upon a working platform which, in turn, is supported on piling driven into the ocean floor. Since such tank battery systems are intended to handle crude oil from a number of wells, the storage tanks ordinarily are quite large. The tanks must hold considerable volume of oil because, in many cases, the crude oil is transferred to shore in tank barges and the battery tanks should be sufficiently large to hold, for example, several days' production from the several wells. It is desirable to continue normal oil production even during inclement weather when ordinary ship or barge transportation will not be possible.

According to my invention I provide an offshore tank battery platform on which is disposed treating tanks, settling tanks, pumping equipment, piping, and the like. In order that the entire platform surface will be available for such use, I have devised a storage tank assembly in which the tanks are supported beneath the working platform.

An object of my invention is to provide an offshore tank battery for handling crude oil.

Another object of my invention is to provide an offshore tank battery in which the entire platform area is available for the oil treating and handling equipment.

Other objects and advantages of my invention will be realized upon reading the following description which, taken with the attached drawing, forms a part of this specification.

In the drawing FIGURE 1 is a side elevational view of the complete assembly of my invention.

FIGURE 2 is an end view of the assembly of FIGURE 1.

FIGURE 3 is a sectional view taken on the line 3—3 of FIGURE 1.

FIGURE 4 is a sectional view taken on the line 4—4 of FIGURE 1.

FIGURE 5 is a sectional view taken on the line 5—5 of FIGURE 3.

FIGURE 6 is a sectional view taken on the line 6—6 of FIGURE 4.

In the drawing reference numeral 11 identifies a template assembly which comprises vertical hollow cylinders or guide pipes 12 held rigidly together by horizontal cross members 13 and 15 and by diagonal cross members 14 and 16, as illustrated. In FIGURES 1 and 2 it is noted that there are 12 of these cylindrical guide pipes fastened together with the above-mentioned braces. This template assembly is constructed on land by welding the various members together in the form illustrated and the assembly is then transported by a ship or barge to the location at which the tank battery is to be constructed. A crane then lowers the template to the floor 27 beneath the body of water 28 with the pipes 12 being disposed vertically. Since these pipes 12 are hollow, each piling 17 is lowered downward and through the pipes 12 until they reach the ocean floor. The piling are then driven into the earth by a pile driver until the top of a section

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of the piling 17 is nearly flush with the top of the surrounding guide pipe 12. Then another section of piling is positioned on top of the driven piling and welded thereto to provide an elongated piling member. The elongated piling is driven further into the ocean floor. This operation is continued until each piling 17 is of the proper length. By this mode of assembly it is realized that each piling is accurately located or positioned. The piling 17 is driven into the ocean floor to such an extent that the tops of the several pilings are in a horizontal plane, or the upper ends are trimmed so that the tops of the several piling are disposed in a horizontal plane, a short distance below the level at which the tanks 18, 19, and 20 are to be positioned.

According to my invention the storage tanks, upper piling sections and flooring are assembled as a unit on land and the unit is floated to location and then raised over the driven piling and the upper pilings 17a guided by spuds 17b are positioned on the upper ends of pilings 17 and welded thereto.

The upper piling joints or sections 17a are positioned through the bottom wall 32 (FIGS. 3 and 4) of the storage tanks 18, 19, and 20 onshore. In the construction of this apparatus as much as possible is done onshore. In the assembly as illustrated in FIGURE 1 each of the tanks 18, 19, and 20 comprises three storage compartments. In tank 18 the compartments are identified by reference numerals 18a, 18b, and 18c. A pair of bulkheads 29 is provided within the tanks to divide them into the three compartments. FIGURE 3 is a sectional view through tank 18 looking in the direction of bulkhead 29 between tank compartments 18a and 18b. In this figure it is noted that top piling member 17a extends up into tank 18 to nearly the top thereof. The pile member 17a is welded to the tank at welds 38 in such a manner as to provide a fluid-tight joint. Around the inner periphery of the tank 18 at bulkhead 29 is disposed an angle iron 31 for reinforcing purposes. This angle iron extends from one side of pipe 17a upward and around the inner periphery of the tank and terminates at the other side of pile member 17a. This angle iron is, of course, welded at both ends to the piling pipe 17a. A small portion of the angle iron 31 is cut away at the top of piling member 17a so that the angle iron can be welded securely to the top of a circular steel plate 39 which is in turn welded to the top of the pipe 17a. Disposed horizontally at spaced intervals from top to bottom of bulkhead 29 are T-beams 30a, 30b, and 30c which are welded at one end to piling 17a and at the other end to the angle iron 31.

The upper piling pipes or sections of piling 17a are, in essence, support columns for supporting the storage tanks 18, 19, and 20.

Bulkhead 29 is composed of two parts, 29a and 29b. Each of these parts is nearly a half circle and each fits in a cross section of the tank between the upper pile section 17a and the wall of the tank and the other part fits on the opposite side of the piling section 17a. Thus, the actual bulkhead assembly comprises a portion of the piling 17a within the tank, bulkhead members 29a and 29b and the angle iron support beam 31. Also, these members are welded fluid-tight so as to isolate, for example, compartment 18c from compartment 18b and compartment 18b from compartment 18a. The circular line of contact of the upper piling section 17a with the tank is sealed by weld 38 so as to be fluid tight. This weld also provides a support for the lower portion of the tank. A cross brace 49 is welded to the upper pile section 17a and extends across to another piling section 17a. Webs 35 are welded in place between braces 49, 23 and the tank wall 32, as illustrated, as additional supports. Disposed on top of the several tanks are a plurality of I-beams 24 each of which is disposed at

right angles or transverse to the axes of the tanks so that each I-beam of this plurality of beams is supported by all of the tanks. As will be noted in FIGURE 3, a lower portion of the I-beams 24 is cut away to accommodate the upper circular wall of each tank so as to provide a relatively large bearing surface between the I-beams and the tanks. These I-beams are attached to the tanks by welds 52. As will be noted from FIGURE 2, diagonal braces 23 extend from each brace 49 below each tank to a point at the top of an adjacent tank. The lower ends of the diagonal braces are welded to the horizontal braces 49 while the upper ends of the diagonal braces are welded to the I-beams 24. The cross braces between two tanks can cross each other in any manner desired; preferably, however, one of the braces is composed of two parts and these two parts are welded to opposite sides of the other diagonal braces to provide a cross brace having the form of an X.

Disposed on top of the several I-beams 24 are a plurality of I-beams 25 and at right angles thereto. Upon these upper I-beams 25 is disposed a working platform upon which is installed the various items of equipment ordinarily used in such offshore crude oil gathering and treating systems. For example, on platform 26 are disposed a heater-treater or oil-water separator 56, a gas-oil separator system 41, a fresh water tank 42, and a crane 43. The gas-oil separating system comprises a plurality of separating tanks 44 which communicate by way of a manifold pipe 45 to the various wells. A pipe 46 conducts separated oil from the separating tanks to the storage tanks 18, 19, and 20. Manifold 54 is provided for disposal of separated gas, while pipe 54a is for disposal of separated water.

Manifold 47 conducts oil from storage tanks 18, 19, and 20 to a pipe 48 which is adapted to be connected to either a pipe line or to a barge for transport of oil from this storage tank battery to shore installations.

FIGURE 4 is a sectional view, taken on the line 4—4 of FIGURE 1. The form of tank support illustrated in FIGURE 4 is used in conjunction with the supports as illustrated in FIGURE 3, the difference being that there is not a bulkhead at the support as illustrated in FIGURE 4. In this figure the upper section of piling 17a extends through the bottom wall of tank 18 and this piling section terminates short of the upper wall of the tank. A T-beam extends around the inner periphery of tank 18 from one side of the piling section 17a to the other side. The uppermost portion of this T-beam rests upon a plate 36 which, in turn, is supported by the upper end of the piling section 17a. Radial braces 33 and 34 are provided as illustrated. These braces 33 and 34 are attached by welding to plates 51 which, in turn, are welded to the T-beam 50. Weld 55 rigidly attaches the wall of the tanks in FIGURE 4 to the upper pile section 17a in a fluid-tight manner. In FIGURE 4 web plates 35 are welded to the lower surface of the tanks and to the braces 49 and braces 23 as additional supports for the tanks.

The I-beams 24 which rest upon the tanks, as illustrated in FIGURE 4, also have cutaway portions for conforming to the upper circular surface of the tanks for provision of large bearing surfaces. Welds 53 rigidly attach these I-beams 24 to the upper surfaces of the tanks.

FIGURES 5 and 6 are sectional views taken on the lines 5—5 and 6—6 of FIGURES 3 and 4, respectively. FIGURE 5 shows bulkhead section 29b with its horizontal T-beam braces 30a, 30b, and 30c, and the angle iron 31 which passes around the inner tank wall 32 and rests upon plate 39.

FIGURE 6 shows the I-beam 50 around the inner tank wall 32 and resting upon plate 36 which in turn is supported by piling member 17a. The radial braces 33 and 34 are shown.

A fender system is provided in conjunction with the hereindisclosed platform assembly for the protection of

the platform assembly and the boats from damage resulting from impacts between the boats and the piling during loading and unloading operations in high seas.

Such a protective fender system is illustrated in FIGURES 1, 2, 3, and 4. Cable support brackets 61 are welded or otherwise suitably firmly attached to the ends of I-beams 24. Eye bolts 62 are passed through the horizontal web of these brackets with the eyes being below the brackets. Yoke and pin assemblies 64 attach the upper ends of bumper cables 65 to the eye-bolts. Nuts 63 adjust the tension of the cables 65. The lower ends of cables 65 are held firmly by a structural assembly comprising a tension member 66, a compression brace 67, and a short member 70. Member 70 is welded to compression brace 67 and to a triangular web plate 68, which in turn is welded to the brace 67. A yoke and pin assembly attaches the lower end of the cables to this lower structural assembly. As mentioned above, the tension of the cables 65 is adjusted by nuts 63.

The I-beams 24 which are disposed directly over the tank partitions or bulkheads 29 require bracing because the cables experience considerable tension as a boat bumps the bumper assembly. Brace 72 is a short section of a 10-inch diameter pipe. This brace is welded to the underside of the beam 24 near the end to which the support brackets 61 are attached, and to the outer wall of the tank, as by welds 76. Within the tanks a compression brace should be provided so that brace 72 cannot injure the wall of the tank when cable 65 is loaded. A 10-inch pipe of the proper length is split lengthwise into sections, and these sections are identified by reference numerals 77 and 78. Pipe section 78 is welded at one end to the inner wall of the tank and at the other end to piling section 17a. The long sides of this pipe section are welded to the bulkhead section 29a.

Semicircular openings are cut into the webs of the T-beams 30a, 30b, and 30c so that the pipe section 77 can be welded to bulkhead section 29a, to the tank wall and to the piling section 17a and to the T-beams. The outer radius of the pipe section 17a is shorter than the length of the webs of the T-beam braces 30a, 30b, and 30c, thus these T-beams fit over the pipe section 77. Thus T-beam braces are preferably welded to the pipe section 77 for improving rigidity of the assembly.

In FIGURE 4 is illustrated bracing for I-beams 24 which are not disposed directly over a bulkhead partition in the tanks. A length of pipe 79 is welded to the underside of the I-beam 24 and to the outer wall surface of the tank. A plate 80 is preferably welded to the tank wall and then brace 79 attached to this plate.

The tanks 18 and 20 are provided with the braces for the bumper cable supporting I-beams while tank 19 is not, obviously, provided with such braces.

A cable 65 with its upper and lower supports are provided at the ends of all I-beams 24, making four such cables on each of the two long sides of the platform assembly.

A fender is provided on the side of the cables to which a boat or barge approaches. These fenders are horizontally disposed structures suspended at the water line, i.e., they extend a short distance below and a short distance above the actual water line. The fenders are the structures which boats contact when docking or when tossed by rough seas. In FIGURES 1 and 2 the fenders 71 are illustrated as to structure and means of support and level adjustment. The fenders are elongated members comprising three or more long members 73 attached to short cross braces 74 as illustrated in FIGURE 1. These fenders are suspended by block-and-tackle assemblies 75. The blocks of the assemblies are supported by the outer I-beams 25 of the platform. The block-and-tackle allows adjustment of the fenders in respect to water level as tides rise or fall. The long members 73 are channel irons, or such structural members as will resist bending, and may

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be covered with suitable cushioning material to prevent sharp contact between the boat and the fender.

One consideration in providing a boat bumper for such a platform structure as herein disclosed is the proper dissipation of the kinetic energy of a moving vessel by the bumper rather than by simple impact on the platform structure. The cables 65 are suspended from the brackets 61 about 10 feet in front of the piling 17 and guide pipe 12 and are attached at the mud line to the brace assemblies as illustrated in FIGURE 2. Upon application of horizontal thrust in the direction of the platform support at about the midpoint vertically of the cable, the cable will deflect from the vertical until the kinetic energy of the moving vessel is absorbed by the cables and the vessel's motion is retarded. The fender is relatively rigid and tends to distribute the impact to all the bumper cables.

The fender system as herein described is usually provided only on the long sides of the platform assembly. However, if desired, they may be provided on only the short sides, or on all four sides.

Placing the oil storage tanks 18, 19, and 20 below the top ends of the piling allows the platform surface 26 to be used for other purposes. In other words, the storage tanks do not utilize a part of the very valuable working surface of the platform. In one instance three storage tanks were 20 feet in diameter by 104 feet long. The tanks were spaced on 30-foot centers and supported by four 30-inch diameter steel pipe piles. Each tank was divided into three compartments. The total storage capacity of the tanks was 17,500 barrels. The template guide pipes 12 were 33 inches in diameter and they extended down into the ocean floor about 8 feet and extended approximately 10 feet above mean sea level.

The separation-storage platform, as illustrated herein, is of a unique and novel design in that the horizontal storage tanks serve the dual purpose of storing produced oil as well as acting as primary structural members of the platform. It should be noted that there are no diagonal braces from piling to piling which extend into a single tank because the tank walls themselves serve as very effective cross braces. However, diagonal braces are provided from the piling extending into one tank to the corresponding piling extending into an adjacent tank.

While certain embodiments of the invention have been described for illustrative purposes, the invention obviously is not limited thereto.

I claim:

1. A fluid storage tank comprising, in combination, a tank of tubular form, the longitudinal axis of said tank being substantially horizontally disposed, an upright support column extending fluid-tight through the lower wall of said tank and terminating short of the upper wall thereof, a tank wall reinforcing and support beam extending from one side of said support column at its point of entry into said tank around the inner periphery of said tank to the opposite side of said support column, the upper portion of said support beam being attached to the upper end of said support column and being supported thereby, and an inlet and outlet to said tank.

2. In combination with the fluid storage tank of claim 1, support braces extending from the support column within said tank to said support beam.

3. A fluid storage tank supported by its upper and lower wall comprising, in combination, an elongated tank of tubular form, the longitudinal axis of said tank being substantially horizontally disposed, a plurality of horizontally spaced upright support columns extending through the lower wall of said tank along its axis and terminating short of the upper wall of said tank, a separate tank wall reinforcing and support beam extending from one side of each support column at their points of entry into said tank around the inner periphery of said tank to the opposite side of said columns, the upper portion of the support beams being attached to the upper end of the respective support columns and being sup-

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ported thereby, the upper and lower tank walls serving as bracing from one support column to another support column of said plurality of support columns, and an inlet and outlet to said tank.

4. A fluid storage tank battery system comprising, in combination, a plurality of elongated tubular tanks, the longitudinal axes of said tanks being approximately horizontally disposed and mutually parallel, a plurality of upright support columns extending fluid-tight and vertically through the lower wall and terminating short of the upper wall of each tank, a separate tank wall reinforcing and support beam extending from one side of each support column at its point of entry into its tank around the inner periphery of the tank to the opposite side of each support column, the upper portion of each support beam being attached to the upper end of its support column and being supported thereby, an inlet and outlet from each tank, a separate structural beam supported on the top surfaces of said plurality of tanks directly above corresponding tank wall reinforcing and support beams, horizontally disposed cross members connecting corresponding support columns of adjacent tanks, and separate diagonal braces connecting the structural beams and corresponding cross members intermediate adjacent tanks.

5. In combination with the fluid storage tank battery of claim 4, a plurality of support braces extending from each support column within the tank to the corresponding support beam, and the tank walls providing bracing for adjacent support columns along the axis of each tank.

6. In the tank battery system of claim 4, a utility platform supported by the top surfaces of said plurality of tanks, said platform comprising in addition to the aforesaid structural beams resting upon said tanks, cross beams supported by and disposed transverse to said structural beams, and a working platform supported by said cross beams.

7. In the tank battery system of claim 6, a crude oil treating system disposed operatively on said platform, a conduit communicating said treating system with said tank battery, and an outlet for stored oil from said tank battery.

8. An offshore crude oil tank battery system comprising, in combination, a plurality of elongated cylindrical tanks, the longitudinal axes of said tanks being approximately horizontal, mutually parallel and disposed at about the same elevation, a plurality of tubular members extending vertically through the lower wall of each of the tanks, said tubular members being fixed fluid-tight to said wall of said tanks, each tubular member of the plurality of tubular members extending into one tank of said plurality of tanks corresponding to a separate tubular member of the plurality of tubular members extending into another and adjacent tank of said plurality of tanks, a first separate horizontal cross brace and support member supported by the upper wall of said tanks, a second separate horizontal cross brace fixed to corresponding tubular members of adjacent tanks and therebelow, diagonal cross bracing members fixed at one end of each to each separate horizontal second cross brace and at the other end of each to each separate first horizontal cross brace, and a platform supported by the first horizontal cross braces.

9. The system of claim 8 wherein said tubular members are the upper end sections of the piling disposed in the floor beneath a body of water and the tank walls being bracing for adjacent tubular members parallel to the axis of each tank.

10. An offshore storage tank and battery system comprising, in combination, a plurality of elongated tubular tanks, the longitudinal axis of said tanks being substantially horizontal, mutually parallel and at about the same elevation, a plurality of vertically positioned tubular members spaced singly along the axis of each tank and extending fluid-tight and vertically from below each tank

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through the lower wall and terminating near and supporting the upper wall thereof, each tubular member of said plurality of tubular members extending into one tank of said plurality of tanks corresponding to a tubular member of the plurality of tubular members extending into another and adjacent tank of said plurality of tanks, a plurality of separate structural beams supported on the top surfaces of said plurality of tanks above corresponding vertical tubular members, a plurality of separate horizontal cross braces fixed to corresponding tubular members of adjacent tanks and therebelow, and a separate diagonal cross brace fixed at one end of each to each horizontal cross brace and at the other end of each to a corresponding structural beam.

11. The system of claim 10, wherein said tubular members are the upper end sections of piling disposed in the floor beneath a body of water.

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12. In the system of claim 11, a platform supported by said structural beams.

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