Oct. 5, 1965 H. C. COOK 3,209,545

OFF-SHORE TRIANGULAR SHIP MOORING STRUCTURE

Filed July 19, 1961 3 Sheets-Sheet 1

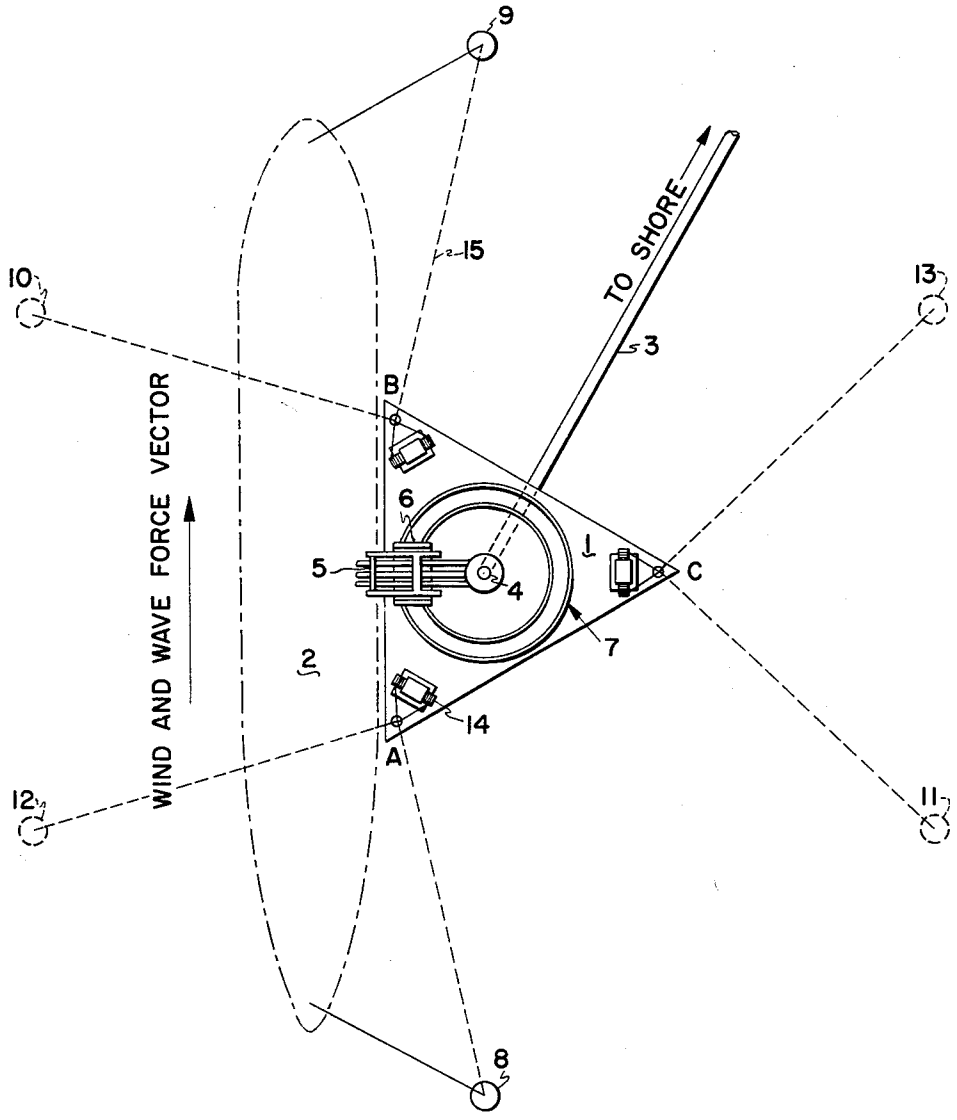


FIG. 1

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OFF-SHORE TRIANGULAR SHIP MOORING STRUCTURE

Filed July 19, 1961 3 Sheets-Sheet 2

MODIFICATION I
FLOATING TERMINAL

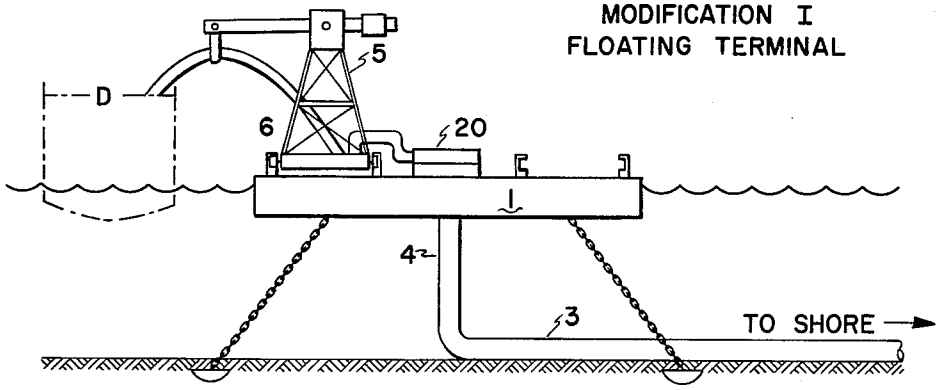


FIG. 2

MODIFICATION II
TEMPORARY TERMINAL

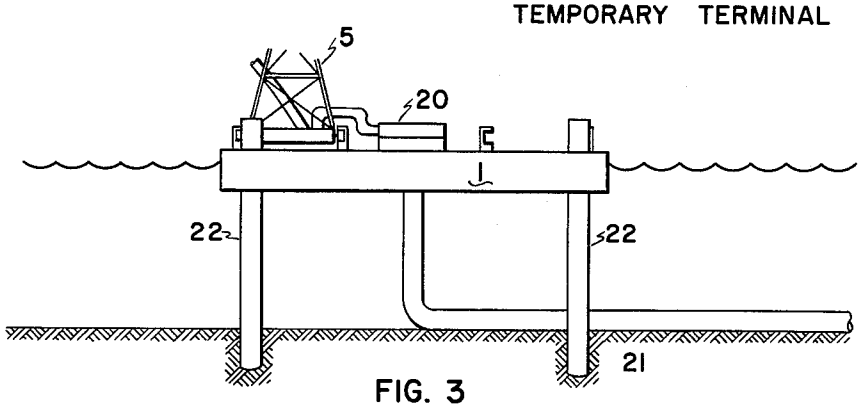


FIG. 3

MODIFICATION III
PERMANENT TERMINAL

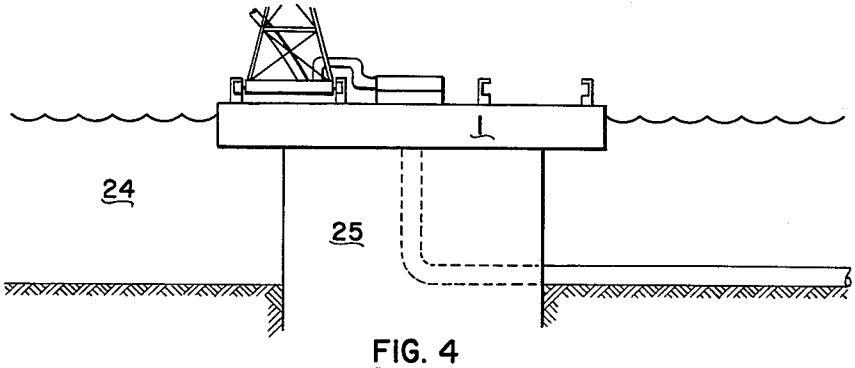


FIG. 4

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OFF-SHORE TRIANGULAR SHIP MOORING STRUCTURE

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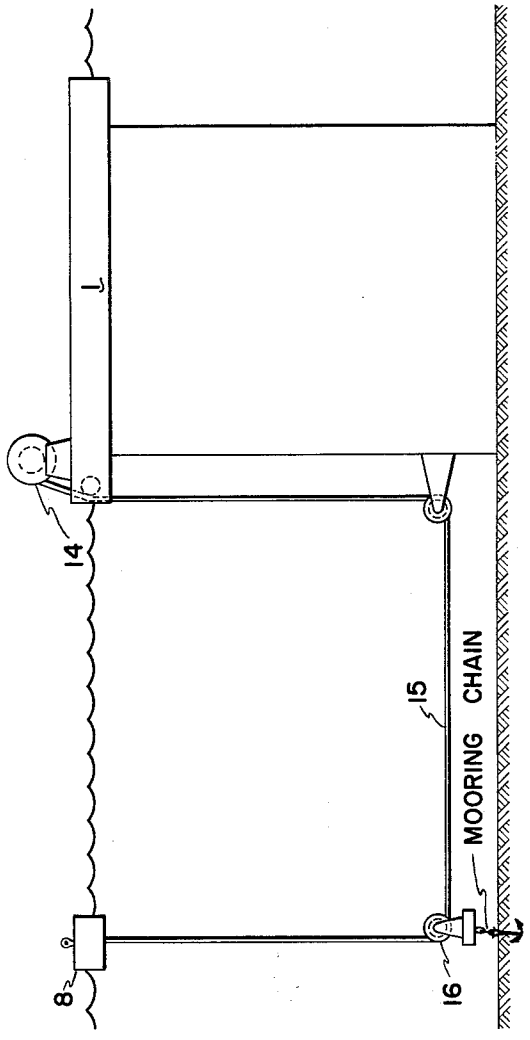


FIG. 5

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OFF-SHORE TRIANGULAR SHIP MOORING STRUCTURE

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Filed July 19, 1961, Ser. No. 125,153
3 Claims. (Cl. 61—48)

The present invention is concerned with an improved off-shore ship mooring and ship loading structure whereby ships and other vessels can be more effectively loaded and unloaded, particularly with fluids such as hydrocarbons, gasolines, crude oils, and the like. In accordance with the present invention, a unique triangular structure comprising a flexible loading arm assembly mounted on circular rails permits the loading of a ship positioned in any one of six different positions. The particular position selected for the mooring of the vessel for a loading or unloading operation will be selected after evaluation of factors including, type of vessel, current conditions, tidal conditions, wind direction, wind velocity, and other considerations. Liquids such as crude oil are then delivered or unloaded to the midship's manifold of the vessel by lines or other conduits positioned on the loading arm assembly. As pointed out, the off-shore loading apparatus of the present invention permits the ship to be positioned in any one of six different headings to minimize the adverse effects of wind, tide, and the like. The apparatus of the present invention also allows the loading or unloading to be made over the rail of the ship in a conventional manner and, furthermore, the structure is flexible so as to handle a vessel of any draft and length.

The efficient mooring of a vessel and the rapid loading of the marine equipment with liquid products as, for example, hydrocarbons and the like, has always presented a complicated problem due to the continuous shifting of the marine equipment or ship being loaded. This shifting of marine equipment is due to among other factors tidal variations, changes in the ship's draft during the loading operations and also wave and wind action. Thus, there exists the problem of continually adjusting the position of the loading hoses to compensate for these changes. Any appreciable change in the relative position of the loading hoses, unless corrected, will cause a severe strain on the tanker connections and, in many instances, cause them to break, thereby putting the tanker out of operation until repairs are effected. This is a very expensive operation. Other difficulties are encountered when attempting to moor ships in various areas due to wave, current and ocean bottom conditions. In order to overcome many of these difficulties, it is known in the art to load ships, such as oil tankers and the like, at piers in protected waters or at marine anchorages or at nose moorings in the open sea.

In the case of tankers at piers, the manifolds of tankers are connected to the pier piping by multiple hoses or flexible arms. In the case of marine anchorages, the tanker manifolds are usually connected to hoses attached to submarine lines. The number of hoses is limited by the necessity of laying them out on the ocean bottom so that they are not tangled. The hoses in these instances must be long, usually 200 feet or more, and the weight, and hence the diameter is limited by the capacity of the ship's gear. Marine anchorages are generally limited to one or two hose connections of 12" diameter or smaller. Tankers are sometimes moored by the bow with hoses extending from the mooring to the bow. However, few tankers have bow connections. On most other tankers, it is necessary either to lay a hose from the bow to the amidship's manifold connections or use a floating hose alongside the vessel. The latter is subject to adverse wave and current actions.

The present invention, as pointed out heretofore, is concerned with an improved off-shore ship mooring and off-shore ship loading device which is characterized by being triangular in shape, thereby permitting the ship to be moored in any one of six positions so as to adjust the ship to the composite vector of tide, wind, sea and current, as well as compensating for the changing buoyancy of the vessel during the loading and unloading operation. The present invention may be readily understood by reference to the drawings illustrating one embodiment of the same.

Referring specifically to the drawings, FIGURE 1 is a top view of the triangular structure showing a ship moored in one position with respect thereto. FIGURE 2 illustrates a floating modification of the same, while FIGURE 3 illustrates a temporary terminal arrangement. The preferred permanent terminal construction is illustrated in FIGURE 4. FIGURE 5 illustrates the unique assembly whereby unused moorings may be submerged so as to permit the vessel to maneuver over these unused moorings onto the moorings to be utilized.

Referring specifically to FIGURE 1, the triangular platform **1** is positioned the desired distance above the surface of the water by suitable means, which means may comprise caissons extending downwardly from the lower side of the platform through the water and embedded in the ocean floor. A vessel **2** is shown moored alongside structure **1** along the side A–B. The bow of the vessel is in the direction of A, which is the composite vector of the wind and wave forces during the interval the vessel is being loaded. The vessel if desired could be moored along side the structure in a direction B–A wherein the bow of the vessel would be in the direction of B if the composite vector were in this direction. Thus, as illustrated, the ship may be moored A–C, C–A, B–C, or C–B. A shore feeding line **3** extends from shore base tanks and leads into the vertical feed line **4** of the structure. A conventional flexible loading arm assembly **5** is mounted on a car **6** which is movable in a circular manner on rails **7**. Moorings **8** and **9** are to be utilized when the vessel is moored in position A–B or B–A. Moorings **10** and **11** are to be utilized when the vessel is moored in positions B–C or C–B, whereas moorings **12** and **13** are utilized when the vessel is moored in positions A–C or C–A.

A unique feature of the present invention is that the moorings that are not utilized are submerged so as to permit the vessel to maneuver thereover. Thus, for example, when the vessel is moored in A–B, moorings **8** and **9** are together utilized in a conventional manner. However, moorings **10**, **11**, **12**, and **13** are submerged so as to permit the vessel to move without hindrance over them onto moorings **8** and **9** which are utilized. This is secured by employing a pulley cable arrangement actuated from structure **1** and as illustrated in FIGURE 5. A winch or reel **14** is positioned on structure **1** in a manner so that cable **15** may be wound or unwound. Cable **15** extends under pulley **16** positioned on the ocean floor in a manner to either submerge buoy **8** or to permit the same to come to the surface. By a similar mechanism, buoys **9**, **10**, **12**, **13**, and **11** may be either raised or lowered utilizing equivalent winches, cables **15** and pulleys **16**. For simplicity, the cables and submerged pulleys beneath the buoys are not illustrated with respect to each mooring.

Referring specifically to FIGURES 2, 3, and 4, similar elements are illustrated with similar numbers. In FIGURE 2, the structure **1** comprises a hollow platform **1** which enables the same to be floated on the surface of the water. Line **3** extends to shore base tanks and to the vertical extending line **4** through a universal loading

element **20**. The loading arms **5** are mounted on car **6** which moves on the rails on the platform.

FIGURE 3 illustrates another slight modification wherein platform **1** is positioned on temporary pilings **22** which extend into the sea bottom **21**. FIGURE 4 illustrates a preferred modification of the present invention wherein platform **1** is positioned above the surface of the sea **24** by means of a heavy caisson **25** which extends into the sea bottom. Thus, the unique feature of the present invention is that it permits the mooring of a ship to a permanent off-shore structure in six different positions and provides flexibility for positioning the loading assembly adjacent the midship loading tubes of the ship. It is to be understood that the structure may contain suitable buffering devices, such as pads and the like and other insulating equipment.

The structure of the present invention eliminates the necessity for the long loading hoses of 100 to 125 feet heretofore required, since the loading lines from the platform on the outboard end of the boom to the ship loading connections will be about from 30 to 50 feet in length.

What is claimed is:

1. An off-shore mooring structure for loading and unloading a liquid cargo from a ship moored thereto; said structure comprising, a fixed caisson permanently secured at its lower end to the sea bottom, a liquid cargo pipeline connected to said caisson and extending to the shore, a triangular platform secured to the upper end of said caisson and extending to a height above the level of the sea, each side of said triangular platform being of relatively short length in relation to the length of the ship to be moored thereto, mooring means extending from each side of said triangular platform for holding the side of the ship to be moored in generally parallel relationship to the associated side of the platform; each of said mooring means of each respective side of the platform including a pair of submerged means secured to the sea bottom and spaced substantially outboard of the ends of their respective side of said triangular platform and towards the corner of the triangular platform spaced from their respective side to which the ship is to be moored, a floating mooring buoy vertically movably secured to each of said submerged means for connection to the bow and stern mooring lines of the ship to be moored, and line means extending from said triangular platform to each of said submerged means and its respective buoy, and winch means located upon

said platform and connected independently to each line means of each buoy for controlling and shortening said line means whereby selected unneeded floating mooring buoys may be submerged to a depth greater than the draft of the ship to be moored; a loading arm assembly movably mounted on track means supported on and defining a continuous horizontal loop about said platform and a ship loading hose supported by said arm assembly and having a liquid flow connection with said pipeline for directing a liquid cargo to and from said ship by moving said arm assembly on said track means to a fixed location adjacent any of the three sides of said triangular platform for use in loading a ship moored to any one of the three sides thereof.

2. An off-shore mooring structure in accordance with claim **1** including pulley means mounted at the lower end of said caisson adjacent the seat bottom for guiding said line means substantially horizontally outward from said caisson to said submerged means.

3. An off-shore mooring structure in accordance with claim **2** wherein said winch means includes an individual winch located at each of the corners of the triangular platform.

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