April 30, 1968 B. F. SAURIN ETAL 3,380,091

SINGLE POINT MOORING ARRANGEMENT FOR TANK SHIPS

Filed Jan. 10, 1966 2 Sheets-Sheet 1

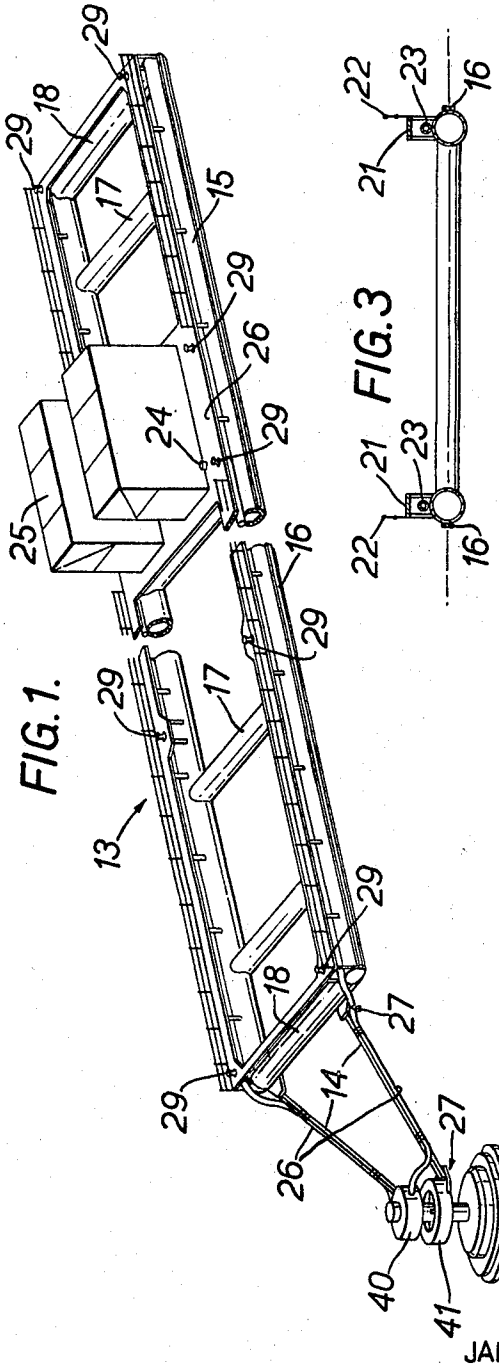

FIG. 1.

FIG. 3

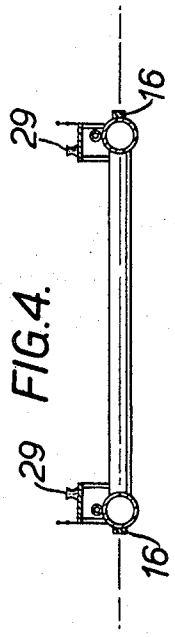

FIG. 4.

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FIG. 2.

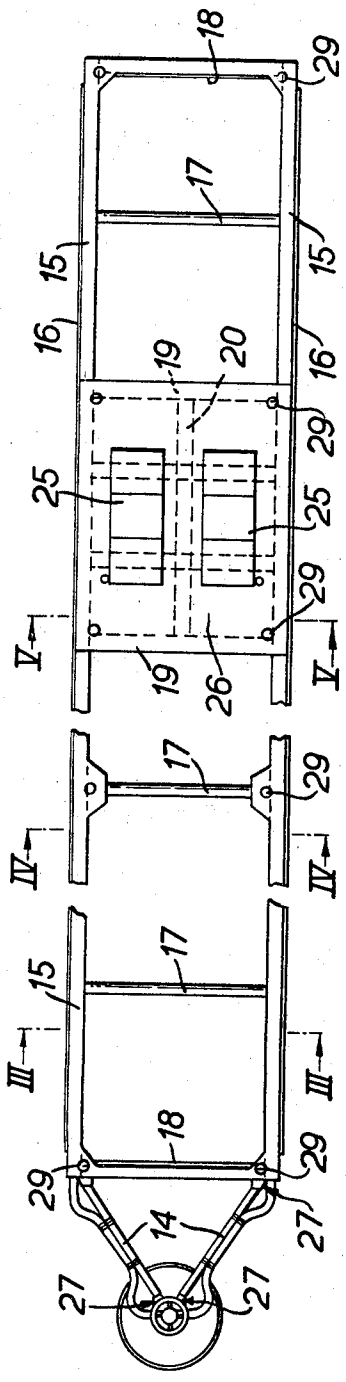


FIG. 6.

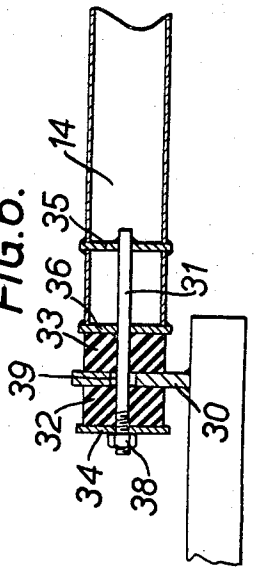
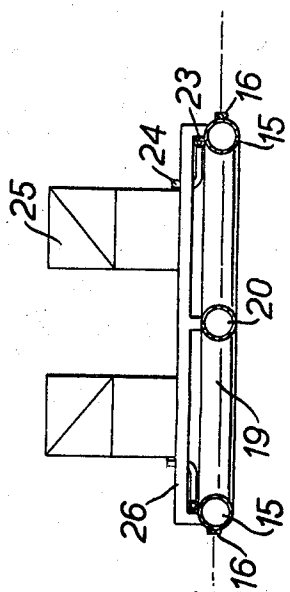


FIG. 5.



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SINGLE POINT MOORING ARRANGEMENT FOR TANK SHIPS

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5 Claims. (Cl. 9—8)

ABSTRACT OF THE DISCLOSURE

A single point mooring arrangement for ships is provided in which a buoy is moored to the sea bed and in which a floating jetty is provided and includes means for attaching the mooring ropes of a ship, and means for attaching the jetty to the buoy. The means for attaching the jetty to the buoy are such that the jetty may both move around the buoy in a horizontal plane and may also move in a vertical plane so as to accommodate the relative motion of the buoy and the jetty caused by tide and wave action.

This invention relates to single point mooring arrangements for ships, especially tank ships.

The last few years have seen the development of single point mooring systems for the loading and unloading of fluid cargoes such as crude oil. These systems are particularly valuable in those oil-producing localities which do not have adequate deep water harbours for handling the very large tankers which are in use today. Normally a single point mooring arrangement consists of a buoy, moored to the sea bed, to which the ship is moored by a bow line and thus the ship can rotate 360° about the buoy according to tide, wind and current. Usually the buoy comprises a mooring swivel to which mooring lines may be attached whereby the rotation is facilitated.

To provide facilities for cargo transference it is usual to run a pipeline from the shore, along the sea bed and up to the buoy and this shore-to-buoy pipeline terminates at a buoy pipeline terminal which is incorporated in the buoy and to which the cargo manifolds of a vessel may be coupled during cargo transference. In order to allow free rotation of the vessel around the single point mooring buoy it is conventional for the buoy pipeline terminal to include a sealed rotary take-off which is often linked with the mooring swivel. In many conventional arrangements flexible hoses are permanently coupled to the buoy pipeline terminal and these are picked up by a moored vessel and coupled to the cargo manifolds.

If a mooring is to be used by tankers carrying a variety of products it would be desirable to lay several independent shore-to-buoy pipelines in order to avoid contamination; a suitable sealed rotary take-off which provides a multi-channel connection is described in British patent specification 977,438. In the case of a mooring which only handles crude oil it would be satisfactory and more convenient to lay only one shore-to-buoy pipeline.

According to the present invention there is provided a single point mooring arrangement for ships comprising a buoy moored to the sea bed, a floating jetty which includes means for attaching the mooring ropes of a ship and means for attaching the jetty to the buoy so that the jetty may both move around the buoy in a horizontal plane and may also move in a vertical plane so as to accommodate the relative movement of buoy and jetty caused by tide and/or wave action.

A particularly suitable means for attaching the jetty to the buoy is formed of one or more, preferably two,

rigid connecting struts each of which is attached, at one end, to the buoy and, at the other end, to the jetty. Where two connecting struts are employed they are most suitably connected to the same point on the buoy and to separate points on the jetty.

In a preferred embodiment each rigid strut is provided with two flexible joints, one at each end, each of which comprises a centre pivot which passes through a hole in a pivot plate, the hole in the pivot plate having a larger diameter than the centre pivot; the pivot plate being clamped between two deformable buffers mounted on the centre pivot whereby the centre pivot is flexibly connected to the pivot plate. The centre pivots, at both ends, may be secured to the rigid connecting strut and the pivot plate at one end to buoy and at the other end to the jetty.

When a single point mooring according to the invention incorporates a pipeline system for the transference of liquid cargo it is convenient to provide a pipeline system which is supported by the jetty; the pipeline system being connected to the buoy pipeline terminal, and providing connection points to which the cargo manifolds of a vessel may be coupled during cargo transference. Conveniently the pipeline on the jetty is connected to the buoy pipeline terminal by means of one or more flexible pipes which may be supported on and protected by the rigid connecting struts.

In a preferred embodiment the jetty comprises a rectangular tubular framework formed of two elongated side arms cross-linked by two tubular end struts and a plurality of tubular cross-struts to provide extra rigidity; the buoyancy of the jetty being provided by the natural buoyancy of the tubes of which it is constructed. With this form of jetty the pipeline may be carried on top of the side arms. In order to facilitate the connection of the cargo manifolds of the vessel to the pipeline system the rectangular tubular framework preferably supports a working platform upon which the connection points of the pipeline are situated.

The buoy to which the jetty is connected is preferably a tensioned-buoy; i.e. a buoy which is held down below its natural level of floatation by its mooring ropes. Such a buoy is described in British patent application 3796/63.

The invention also includes a modification of the single point mooring arrangement described above in which the buoy is replaced by a piled structure built up from the sea bed.

One embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a general view of a single point mooring arrangement according to the invention,

FIGURE 2 is a plan view showing the jetty and its attachment to the buoy,

FIGURE 3 is a cross sectional view of the jetty across the line III—III as shown in FIGURE 2.

FIGURE 4 is a cross sectional view of the jetty across the line IV—IV as shown in FIGURE 2,

FIGURE 5 is a cross sectional view of the jetty across the line V—V as shown in FIGURE 2, and

FIGURE 6 is a cross sectional view showing detail of a flexible joint incorporated in the linkage between the jetty and the buoy.

The mooring illustrated in FIGURE 1 comprises a ground anchor system **10** to which a buoy **11** is anchored by means of anchor cables **12**. The buoy is of the tensioned type; that is the anchor cables **12** are of such a length that the buoy is held down below its natural level of flotation. It is emphasized that this requirement applies even at low tide and this implies that the buoy may be totally submerged at high water. For example a buoy

which is moored at a location where the tide rises 15 feet may be 10–15 feet under water at high tide.

A floating jetty **13** is moored to the buoy **11** by means of rigid connecting struts **14** which are connected to the buoy and in particular to a conventional swivel **40** which is part of the buoy and which permits the jetty to revolve 360° around the buoy.

To provide for cargo transference a pipeline **42** is laid on the sea bed and up to a buoy pipeline terminal **41** which forms part of the buoy **11**. A jetty pipeline system, described below and illustrated in the other figures, is connected to the buoy pipeline terminal **41**. To accommodate the rotation of the jetty **13** the buoy pipeline terminal includes a sealed rotary take-off which may be connected to the swivel **40** to ensure that the two rotate together.

As shown in FIGURE 2 the jetty is formed of a rectangular tubular frame work formed from two side arms **15** which are provided with fenders **16** along their outboard extremities and two end struts **18**. Additional rigidity in the framework is provided by cross struts **17**. All these members are of tubular construction to provide the buoyancy needed to keep the jetty afloat. Bollards **29** are secured to the framework to provide a means for attaching the mooring ropes of a ship.

As shown in FIGURE 1 the jetty is connected to the buoy **11** (and in particular to the swivel which is part of the buoy) by means of connecting struts **14**. Since the buoy does not rise and fall with the tide and it is less subject to wave action (particularly when it is under water at high tides) than the jetty the linkage needs to be flexible and both ends of each of the connecting struts **14** are provided with a flexible joint **27**. A suitable joint is illustrated in greater detail in FIGURE 5.

In addition to providing mooring for a tank ship the jetty also provides a pipe-line terminal for cargo transference and rigid pipe-lines **23** are carried on top of the side arms **15** and connected to the buoy terminal pipe-line **41** by means of the flexible pipes **26**. To reduce wear the centre portions of the flexible pipe-lines may be lashed to the connecting struts **14**.

The side arms **15** and the end struts **18** also carry a walk-way **21** which is provided with a hand rail **22** and this provides access around the perimeter of the jetty. In the vicinity of a bollard **29** the walk-way **21** is widened out to provide room for the handling of mooring lines.

FIGURE 3 is a cross section of the jetty which shows the pipe-line **23** carried on the side arm **15** beneath the walk-way **21** which is provided with hand rail **22**. This figure also shows the fender **16** and that the cross strut **17** has a smaller diameter than the side arm **15**.

FIGURE 4 is a similar cross section to FIGURE 3 but taken in the vicinity of a bollard **29**. This figure also illustrates the widening of the walk-way **21** in the vicinity of the bollard.

The jetty is provided with an operating platform **26** which carries the hose handling equipment **25** (since a wide variety of hose handling equipment is available no details are shown, the location being indicated by means of rectangles) and because this imposes extra load upon the framework extra bracing is provided by four additional cross struts **19** and a centre longitudinal strut **20**. All of these have the same diameter as the side arms **15** and they are all of tubular construction to provide extra buoyancy to counter-balance the additional weight of the platform **26** and the hose handling equipment **25**.

FIGURE 5 is a cross section through the platform **26** which shows the larger diameter of the additional cross struts **19** and the centre longitudinal strut **20**. This figure also shows the termination of the pipelines **23** and the provision of side branches **24** which provide connection points to which the cargo manifolds of a ship may be coupled during cargo transference.

FIGURE 6 is a cross sectional view showing detail of the flexible joints indicated by numeral **27** in FIGURE 2.

The joint is formed from a centre pivot **31** which passes through a hole **39** in a pivot plate **30**. The hole has a greater diameter than that of the centre pivot so that considerable annular movement is permitted.

The centre pivot **31** is secured to the connecting strut **14** by welding it to an internal plate **35** and end plate **36**. The pivot plate is welded to the member to which the connecting strut **14** is connected (i.e. the jetty at one end and the swivel of the buoy at the other). The pivot plate **30** is clamped between rubber buffers **32** and **33** which are compressed between the end plate **36** and the face plate **34**, the compression being applied by the tightening of the nut **38**. The rubber buffers hold the flexible joint secure against the tension (and occasional compression) due to movement of the jetty but the flexibility of the rubber permits sufficient angular distortion to accommodate the rise and fall of tide and wave action.

The embodiment of the invention described above is intended for the unloading (or loading) of crude oil and therefore only one shore-to-buoy pipeline is provided. However the pipeline branches at the sealed rotary take-off (as shown in the drawings) to give more flexibility of working.

We claim:

1. A single point mooring arrangement for ships with comprises a buoy moored to the sea bed, a floating jetty which includes means for attaching the mooring ropes of a ship, and means for attaching the jetty to the buoy, the means for attaching the jetty to the buoy being such that the jetty may both move around the buoy in a horizontal plane and may also move in a vertical plane so as to accommodate the relative motion of the buoy and the jetty caused by tide and wave action, said jetty attaching means being formed of at least one rigid connecting strut which is attached at one end to the buoy and at the other to the jetty and said jetty attaching means also comprising two flexible joints associated with each rigid connecting strut, one flexible joint being situated at each end of each strut, each flexible joint comprising a centre pivot and a pivot plate, the pivot plate having a hole of larger diameter than the centre pivot and the centre pivot being passed through said hole, each centre pivot being secured to one of the rigid connecting struts, each pivot plate which is comprised in a flexible joint at the buoy-end of a strut being secured to the buoy, and each pivot plate comprised in a flexible joint at the jetty-end of a strut being secured to the jetty, each flexible joint also comprising two deformable buffers which are mounted on the centre pivot and between which the pivot plate is clamped whereby the centre pivot is flexibly secured to the pivot plate.

2. A single point mooring according to claim **1**, in which the means for attaching the jetty to the buoy is formed of two rigid connecting struts each of which is attached at one end to the buoy and at the other end to the jetty.

3. A single point mooring arrangement according to claim **1**, which comprises a pipeline for the transference of liquid cargo which comprises a jetty pipeline system supported on the jetty and a link pipeline system which connects the jetty pipeline system to the buoy pipeline terminal, the link pipeline system comprising one or more flexible hoses which are supported on and protected by the rigid connecting struts.

4. A single point mooring arrangement according to claim **1**, in which the jetty comprises a rectangular tubular framework which is formed from two tubular side arms, two tubular end struts and a plurality of tubular cross-struts, the side arms and end struts being connected at their ends so as to form a rectangle and one end of each cross-strut being secured to one side arm at a point intermediate its ends and the other end of the same cross strut being secured to the other side arm at a point intermediate to its ends so as to strengthen the structure, the buoyancy of the jetty being provided by the natural buoyancy of the tubes of which it is constructed.

5. A single point mooring arrangement for ships which comprises: a buoy moored to the sea bed, a floating jetty which includes means for attaching the mooring ropes of a ship, and means for attaching the jetty to the buoy, the means for attaching the jetty to the buoy being such that the jetty may both move around the buoy in a horizontal plane and may also move in a vertical plane so as to accommodate the relative motion of the buoy and the jetty caused by tide and wave action, said jetty attaching means being formed of two rigid connecting struts each of which is attached at one end to the buoy and at the other end to the jetty and said jetty attaching means also comprising four flexible joints, one flexible joint being associated with each end of each of the two rigid connecting struts, each flexible joint comprising a centre pivot plate and a pivot, the pivot plate having a hole of larger diameter than the centre pivot and the centre pivot being passed through said hole, each centre pivot being secured to one of the rigid connecting struts, each pivot plate which is comprised in a flexible joint at the buoy-end of a strut being secured to the buoy, and each pivot plate comprised in a flexible joint at the jetty-end of a strut being secured to the jetty, each flexible joint also comprising two deformable buffers which are mounted on the centre pivot and between which the pivot plate is clamped whereby the centre pivot is flexibly secured to the pivot plate.

References Cited

UNITED STATES PATENTS

2,882,536	4/1959	Jordan	9—8
3,014,710	12/1961	Layne	61—48 X
3,155,069	11/1964	Ross et al.	9—8 X
3,177,838	4/1965	Grimes	114—230
3,209,545	10/1965	Cook	9—8 X
3,236,266	2/1966	Bily	114—230 X
3,285,213	11/1966	Whittle	114—.5

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