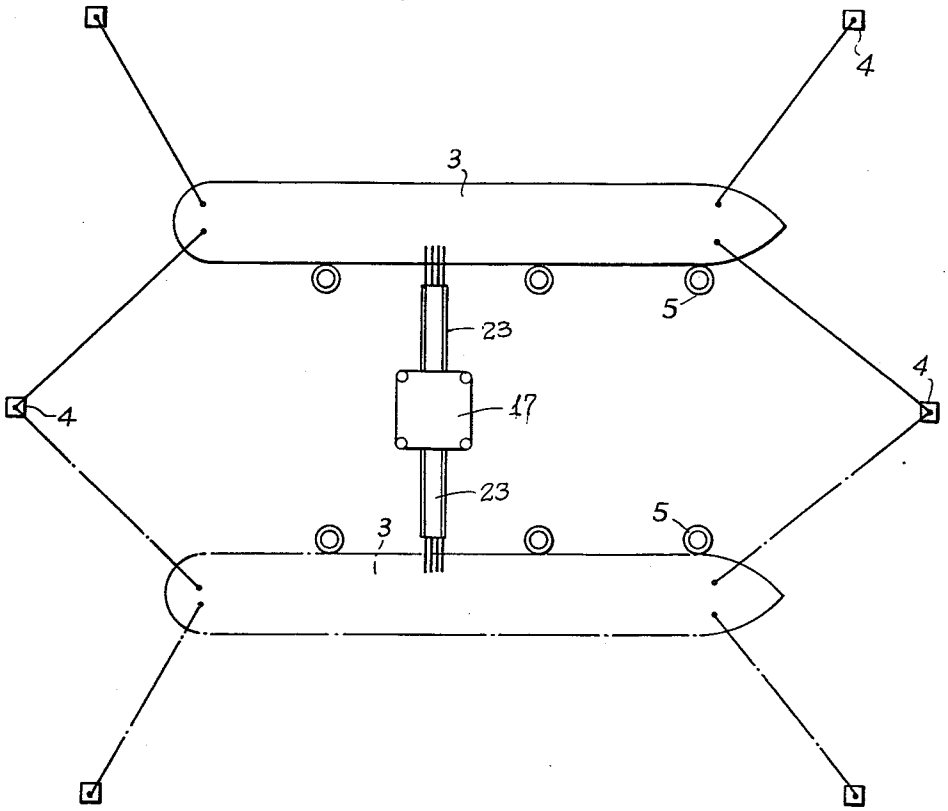
May 7, 1963 W. WALLACE 3,088,286

OFF-SHORE TERMINALS

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Fig. 1.



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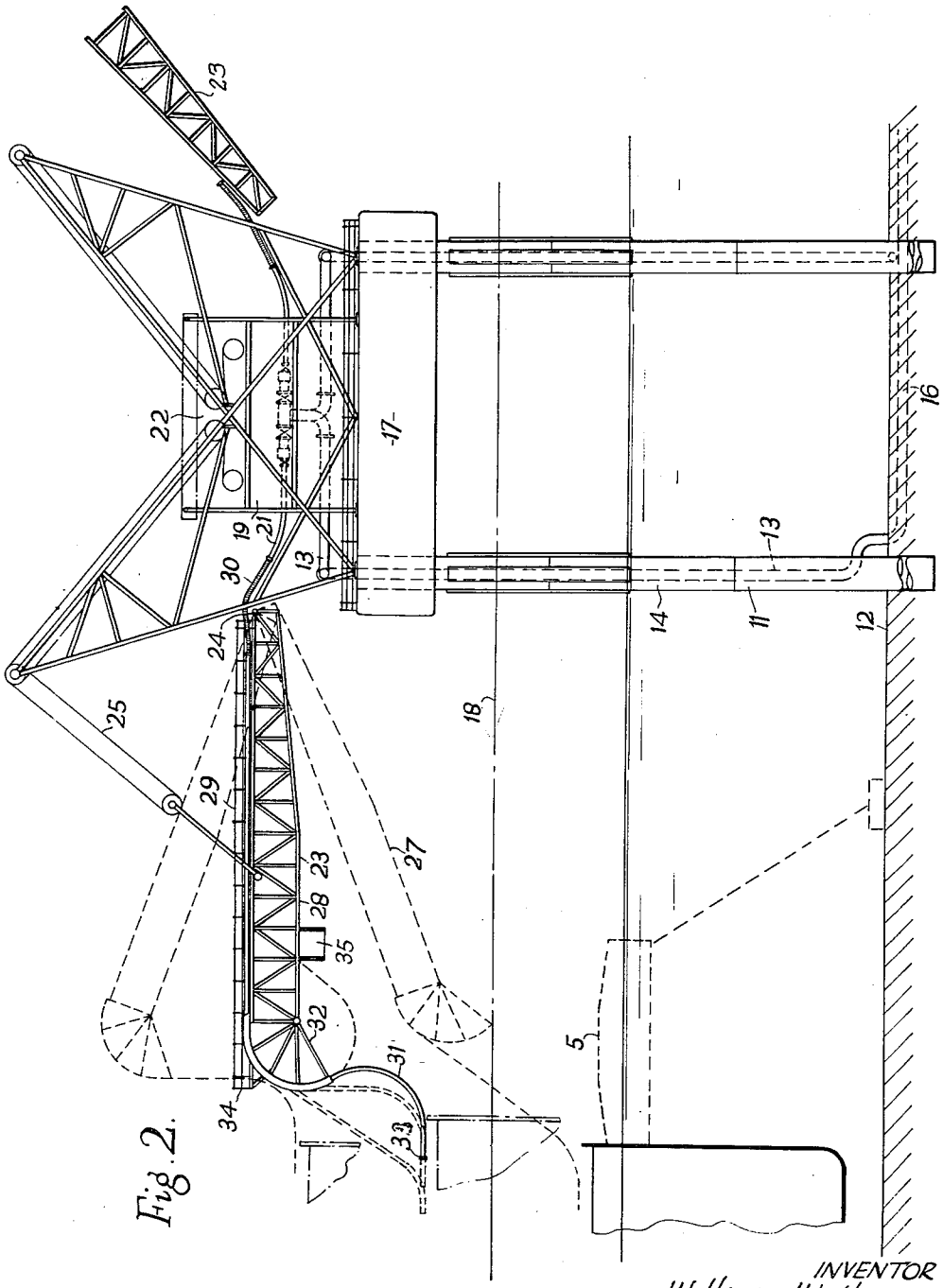


Fig. 2.

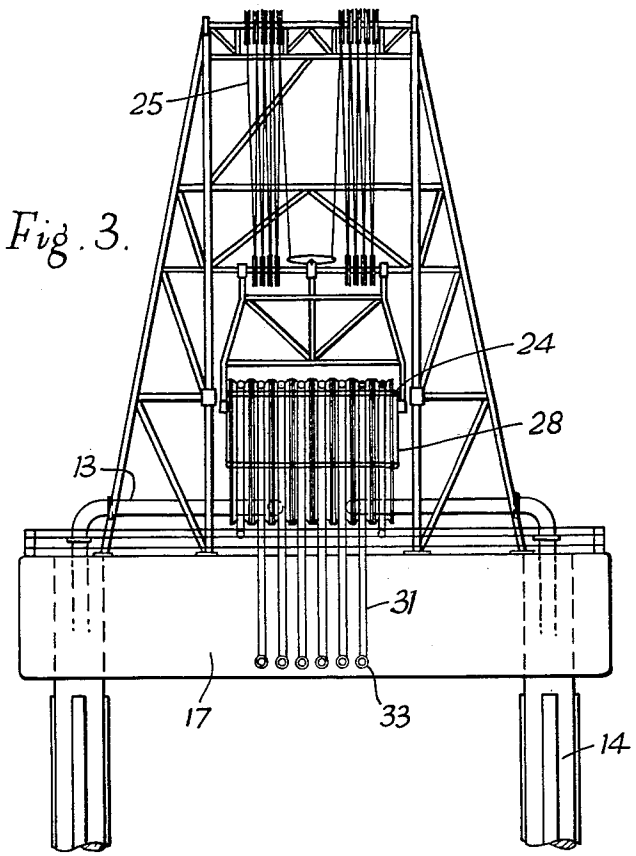
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Fig. 3.



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OFF-SHORE TERMINALS

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2 Claims. (Cl. 61—46)

This invention relates to off-shore terminals.

With the development of tanker vessels of very large size and capacity, difficulties are being found in providing the necessary port terminals where these can load or discharge their cargoes. Existing ports or harbours are often not large enough and deep enough to accommodate vessels of considerable size and it is not always economical to reconstruct such harbours or ports and to dredge them to accommodate such vessels. This is particularly the case at the loading stations near the oil wells where harbour facilities tend to be somewhat primitive. In addition, it would often be economically highly satisfactory to provide a point where oil could be loaded or unloaded and where existing port facilities are not available even for relatively small ships.

To meet this need, off-shore terminals at which a ship can moor, or adjacent to which it can anchor, have been proposed. In one form this is comprised simply by a number of static pipelines which are laid along the sea bed, and which terminate in lengths of flexible piping which are capped and buoyed and which can be picked up by a vessel anchored or moored to fixed mooring buoys in a suitable position. A tender is normally available at the terminal to assist the ship in the picking up of flexible pipes. Such an arrangement is not wholly satisfactory, since the ships' anchors may foul the pipelines, or, if the ship is not sufficiently accurately positioned, its movement in the sea may cause the flexible pipelines to be broken or to become disconnected from the pipelines upon the sea bed. An alternative arrangement comprises a floating platform which is securely moored in position and which is connected to the shore by pipelines lying on the sea bed and by lengths of flexible pipelines rising from these to the floating platform. The platform is sufficiently securely anchored to allow the ship to moor to it, and flexible pipelines are then passed between the ship and the floating platform to allow the transfer to take place. The ship may ride around the floating platform without risk of straining the pipes since it is moored volves problems of safe-guarding the platform and moorings against fouling, and still requires the use of a tender to assist in the mooring and pipeline connecting operations. In addition, particularly in heavy weather, or if a sudden change of weather should take place, there is the risk that the ship itself may foul the floating platform itself, particularly since it is not moored or anchored, apart from its connection to the platform. In an attempt to overcome these disadvantages it has been proposed to provide a larger sized platform which is fitted with a jib crane which can be used to sling the connecting pipelines to the stern of a ship anchored close to the terminal. Such an arrangement means, however, that the tanker must anchor with its stern very close to the terminal and this can make the terminal quite unusable during heavy weather. In addition, in all of the suggested constructions of terminal which have previously been proposed, it has not been possible for the pipeline connections to be made to the normal connection points upon a vessel. These are usually situated amidships of the vessel and to either the port or starboard side (or both). Since the previous arrangements have normally involved pipeline connections either at the bow or stern of the ship, this has meant that connection pipelines have had to be provided laid along the deck of the ship.

It is an object of the present invention to provide an off-shore terminal which is not subject to these disadvantages, which will accommodate at least two vessels at a time, and where no tender other than assisting tugs and mooring launches is required to assist in the linking-up of the pipelines between the terminal and the ship.

According to the invention an off-shore terminal is provided connected to the shore by pipelines in which connections from the pipelines are carried upon an overhead structure to a point above a vessel moored or anchored in a desired position relative to the structure, connections being provided to be lowered from said point to be secured directly to the normal connection points upon the vessel.

The terminal preferably includes a number of dolphins or suitable mooring buoys to which the vessel can be moored. Alternatively, a number of suitable marker buoys can be provided, and the vessels can anchor in a position indicated by these so that it is correctly located relative to a central terminal from which overhead structures may extend to carry pipelines to the vessel.

The terminal itself will normally be located substantially centrally of the dolphins or indicating buoys and although it may be a floating structure anchored in position, it is preferred that it should be in the form of a tower having its foundations on the sea bed.

The terminal structure itself may be in the form of a tower of substantial construction surrounded and protected by an annular, energy absorbing, wharf structure and extending a considerable height above the high water mark. Upon the upper region of the tower structure, one or more structures may be supported to extend outwardly from the tower to carry flexible pipelines, which may be flexible hoses or which may be short lengths of rigid pipe joined by flexing joints such as Chicksan joints which are to be passed to a ship. In a preferred construction, the pipeline carrying structure may be in the form of a balanced boom extending an equal distance in diametrally opposite directions from the tower to provide two stations from which pipelines may be passed to moored ships. If desired, however, three or four or more counter-balanced booms may be provided, each of which can be independently rotated to traverse about the tower to bring them into a suitable position relative to a moored ship to which they are to be coupled. In an alternative preferred construction, the pipeline carrying structure may be in the form of a bridge or boom extending outwardly from the main tower of the structure and being able to be luffed or otherwise raised and lowered between a stowed position and an operative position.

Pipelines to the terminal may extend along or under the sea bed from the shore to the base of the terminal tower. Here, they are connected to pipelines extending centrally up the tower by means of a somewhat

flexible connection which will allow them any slight relative movement which may occur, for example by the settling of the foundations of the tower or by the slight movement of the sea bed due to ground bed movement. At the upper end of the tower each of the several pipelines may be connected into a manifold that may be annular, these manifolds being in turn connected to the pipelines extending along the boom structures and coupled at the ends to flexible pipelines to be lowered to the ship from above its deck height. Since each of the several pipelines extending from the shore to the terminal and then up the tower to the manifolds will generally be of greater diameter than can conveniently be used to extend along the booms and to the ships, each manifold may be connected to a number of smaller pipes having the same total carrying capacity extending along the booms.

The flexible pipes to be lowered to the moored vessels may pass over a pulley or a drum located at the end of the boom and may then extend in a loop either downwardly from the end of the boom or else inwardly towards the terminal tower, suitable weights, springs or brakes being provided to ensure that an excess of flexible pipeline is never lowered into a position which it can be fouled by the ship, whilst at the same time sufficient slack is always available to allow for any movement of the ship relative to the terminal. Such an arrangement will also ensure that when the pipelines are disengaged from the ship and capped, they may be released and will retract to the end of the boom.

Where a crew of operators is required upon the terminal to rotate the booms and to lower the hoses to a ship connected to the terminal, suitable watch-keeping or even living accommodation may be provided upon the terminal, which may also house auxiliary pumping equiment, power and lighting plant, navigation control gear, and communications instruments, and a stock of small stores. A helicopter landing platform could also be provided where necessary.

In order that the invention may be clearly understood, some embodiments thereof will now be described by way of example only with reference to the accompanying diagrammatic drawings in which

FIG. 1 is a plan view showing the general arrangement of a terminal according to the invention with two vessels in the loading position.

FIG. 2 is an end view showing the detailed construction of a terminal according to the invention, and

FIG. 3 is a part side view of the terminal shown in FIG. 2.

The general arrangement of the terminal acocrding to the invention can best be seen from FIG. 1. The terminal structure comprises a substantial tower **1** standing upon the sea bed, and extending to a height considerably above the high water mark. From this, overhead structures or bridges **2** extend to carry pipelines from the central tower structure to ships **3** moored in position to load or unload their cargoes. The ships are securely moored to mooring blocks of buoys **4** which are firmly anchored to the sea bed, and the accurate positioning of the ships is further assisted by dolphins **5** similarly moored to the sea bed and extending in a line along the side of the fairway between the tower structure and the mooring point for the ships. In the particular construction of the invention illustrated, facilities are provided for two ships to be moored alongside the terminal to load or unload their cargoes.

The structure of one form of terminal according to the invention is shown in greater detail in FIGS. 2 and 3. This comprises a tower, the foundations of which rest in the sea bed, and which supports at its upper end a multi-deck structure. From this structure extend overhead bridges which reach outwardly from the central tower so that their ends can be positioned over a ship which is moored alongside the dolphins. Pipeline connections which may be laid on or under the sea bed and which serve to carry oil or other cargo to or from the shore and which also serve to provide supplies of fresh water and fuel to the ship, are carried up the tower. Here they pass through a valve house from which smaller diameter pipes pass along the overhead bridges to a point where they can be lowered to the ship to be fitted on to the normal connection points of a vessel.

The tower structure may comprise large diameter tubular steel legs **11**, the foundation of which is located in the sea bed **12**. In the structure shown, four such legs are provided, but it will be appreciated that if desired the structure may be supported upon a greater number of legs. In addition, cross bracing may be provided between the legs in order to give the tower the necessary rigidity. The terminal-to-shore pipelines may if desired be carried up the tcwer through the centre of the legs of the tower structure and in this case one or more pipes **13** may be provided within each leg. If desired, the structure can be further strengthened after it has been assembled by filling the space **14** between the internal pipelines and the outer casing of the legs with concrete.

The pipelines **13** which are carried up inside the legs may be of about twenty-four inches diameter, and may be connected by sections **15** to the main pipelines **16** which extend to the shore. The connection **15** is preferably arranged so that it has some flexibility to allow for any relative movement which may take place between the terminal and the shore pipelines as a result of settling.

The superstructure which is carried upon the top of the legs is a multi-deck structure, the bottom **17** of which is located some distance above the high water mark **18**. The lower decks of the hollow structure are conveniently completely encased and may be provided with storage space and tankage space. The lower decks may also include living quarters for the crew or watch-keeping personnel and auxiliary services, such as electric generators, pumps to provide a compressed air supply, and the like.

The upper decks of the superstructure, which may if desired be of smaller lateral dimensions than the lower decks and centrally disposed upon the lower decks may include a valve house **19** into which the large diameter pipes **13** are led. From the valve house pipes **21** of smaller diameter, for example six to ten inches, pass outwardly on to the bridges to be carried to the ships. It is preferred that a larger number of smaller diameter pipes **21** should be used for the connections rather than large diameter pipes such as the pipes **13** since they are more convenient in use and will match up with the connections upon the ships. Generally, however, the carrying capacity of the larger number of pipes **21** will be equivalent to the carrying capacity of the smaller number of larger pipes **13**.

The superstructure also includes a winch room **22** in which the winches, motors and generators are provided which are used to control the movement of the bridges.

The overhead bridges **23** are pivotally secured to the main superstructure at **24** and arranged so that they can be moved by means of the luffing ropes **25** and the winches in the winch house **22** between an upper operating position shown in hatched lines at **26** and a lower operating position shown in hatched lines at **27**. Each bridge consists of a rigid framework structure **28** which is decked upon its top surface and which carries a number, for example 8, servicing pipes **29** of six to ten inch diameters. These pipes are mounted in guides upon the bridge and are connected to the pipes **21** from the valve house by means of a flexible connection **30** which will allow for the movement of the bridge. At the end of the bridge the service pipes are connected to flexible hoses **31** of a corresponding diameter which lie in guides over a spider **32** and which are provided upon their ends

with valved fittings 33 to be secured to the deck connections upon the ship. The service hoses can then be lowered directly on to the deck of the ship to be connected to the normal connection points upon the deck. Considerable lengths of pipe may be carried upon the spider and each pipe may be individually controllable to lower it to the deck of the ship or to raise it from the deck. The hoses are, however, held in such a manner that they can run out and back to a considerable degree as a result of tensions applied to them. By this means any chance of a hose being snapped or disconnected due to movement of the ship relative to the bridge is reduced to a very slight possibility. The bridge is provided with an observation or controlling station 34 from which movement of the bridge itself and of the pipes can be either observed or controlled to assist in the accurate lowering of the pipes to the correct position upon a moored vessel. The bridge may also be provided with a suitable housing 35 into which the ends of the pipes can be drawn whilst they are not in use.

When a bridge 23 is not in use it can be raised into a stowed position as shown at the right in FIG. 2 and locked in this position. The ends of all of the service hoses will at this time be contained within the housing 35, and the whole of the bridge structure is positioned so that it is well clear of all parts of the superstructure of a ship being berthed, so that there is no chance of any part of the bridge structure being fouled by the ship even if the ship should be subject to considerable movement during relatively heavy weather.

When a ship desires to use the terminal, it is brought into position alongside the dolphins 5 and moored to the mooring blocks 4. In some cases it may be necessary to use tugs to bring the ship into the correct position or to carry the mooring ropes to the ship, but under certain circumstances this may be abe to be avoided. Once the ship is securely moored in position the bridge may be unlocked from its stowed position and lowered under the direction of an operator upon the observation station, and when the bridge is in the correct position relative to the deck of a ship, which will depend to a considerable extent upon the state of the tide, the service hoses which are required may be lowered to the deck of the ship and secured to the connections upon the deck. Several service hoses may be used for the loading or unloading of the ship's cargo whilst others may be used to provide supplies of fresh water, fuel oil, or other requirements. Once the service hoses are connected in position the transfer of liquids between the ship and the shore may be commenced, the pumping taking place either upon the ship or upon the terminal or upon the shore. If desired, a ladder may be lowered from the observation post upon the deck of the bridge to the deck of the ship to provide for access between the vessel and the terminal. Telephonic or other communication may also be established at the same time and in a similar manner. Whilst the ship is connected to the terminal, it is necessary that the bridge should be moved up and down to correspond to the movement of the ship with the tide, although small movements such as may be produced by waves can be accommodated by the use of considerable lengths of hose, connected in such a manner as to allow them to flex when they are put under tension. If desired, the movement of the bridge structure to correspond to the movement of the ship with the tide and the lowering of the ship in the water as it is loaded may be achieved automatically and may for example be controlled by the tension in a bridge to tanker line. When a ship has completed the loading or discharge of its cargo, the procedure for leaving the terminal is exactly the reverse of the procedure used in connecting it to the terminal.

It will be appreciated that many variations can be made in the construction of the terminal and many additional services to those described may be provided. For example, the main central structure of the terminal may be a floating structure and this may either be anchored in position by mooring chains or alternatively it may be held in position and guided in its up and down movement with the tides by means of one or more column structures having their foundations in the sea bed, and passing through suitable guide channels in the floating structure. Alternatively, the terminal structure may be constructed with a central tube of considerable diameter which will carry oil and service pipes between the superstructure and a chamber on the sea bed where the service pipes can be connected to the terminal-to-shore pipes. This central tube can be made accessible so that operators can reach all points on the tube and can also gain access to the chamber below the sea bed. At the pipe connections in the sea bed chamber arrangements may be made so that a pig may be inserted into the terminal-to-shore pipelines and blown through them to clear and clean the pipes over their entire terminal to shore lengths.

In addition, it is desirable that the terminal should include a mooring platform or barge in the fairway between the dolphins and the central structure with means of access between this and the superstructure and a derrick for the handling of stores. It will also be fitted with navigational lights and may serve as a radio station and meteorological station. It is also desirable that the terminal should be fully equipped with fire-fighting equipment, the main pumps of which may be contained within the superstructure, and suitable outlets and monitoring positions may be provided both upon the superstructure and upon the bridges. The terminal may also include provision for the bunkering and servicing of tugs, launches or other small vessels and these facilities may be so arranged that they can be made available to small vessels moored in the fairway between the dolphins and the main superstructure of the terminal. The terminal will also be in connection with the shore by means of telephone, the cable for which may be laid with the terminal-to-shore pipelines and if desired, the terminal may also be provided with a helicopter landing platform.

Furthermore, whilst the terminal has been described with specific reference to its use for loading and unloading liquid cargoes such as oil, it will also be used for the handling of granular solid cargoes which can be transferred through pipelines in a suitable carrier such as compressed air. By this means, grain and similar cargoes may be able to be handled in a like manner. The terminal may also be used for the handling of very low viscosity products such as some crude oils by providing means for heating these, steam tracing to maintain their temperature as they pass through the pipes and lagging to prevent heat losses.

I claim:

1. In an off-shore terminal connected to shore by pipelines and including a tower having its supporting columns positioned on foundations in the sea bed, a deck structure on said tower; the improvement comprising a rigid framework structure positioned on said deck structure, and framework structure having oppositely disposed sections extending outwardly from the opposite sides of said deck structure and having interconnecting sections therebetween, a pair of oppositely disposed balanced booms pivoted to said framework, an arcuate extension on the outer end of each of said booms and cables adjustably connecting said outwardly extending sections of said framework and said booms for movably supporting the same, flexible hoses secured to each of said booms and extending over said arcuate ends thereof and communicating with said pipelines.

2. The off-shore terminal set forth in claim 1 and wherein winches are located on said interconnecting sections and wherein said cables are operatively received

by said winches and arranged so that said cables may be moved thereby so as to move said booms.

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