

# United States Patent [19]

Karl et al.

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## [54] AUTOMATIC MOORING SYSTEM

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[51] Int. Cl..... B63b 21/00  
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9/8 P, 8 R; 141/279, 284, 387, 388;  
214/12-14; 61/46, 46.5

## [56] References Cited

### UNITED STATES PATENTS

3,199,553 8/1965 Garrett et al. .... 141/388  
3,430,597 3/1969 Zunderdorp..... 9/8 P  
3,754,581 8/1973 Taggart..... 141/387

Primary Examiner—Trygve M. Blix

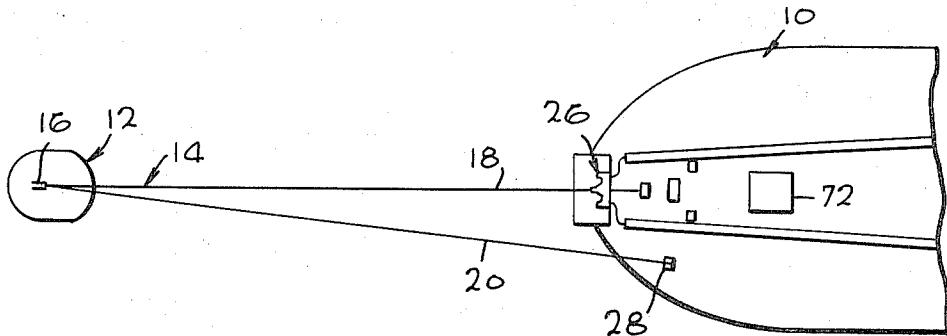
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## [57] ABSTRACT

A system for mooring a ship to a buoy and making hose connections between them, using only personnel who remain on the ship, including a pulley on the buoy and a hauling line extending about the pulley and with its opposite ends lying in the water. The ship picks up the ends of the hauling line, attaches one end to a mooring block and the other to a winch, and operates the winch so that the block is pulled from the ship to the buoy. The mooring block contains pulleys about which hose lines extend, so that after the block is secured to the buoy one end of each hose line can be attached to a hose and the other to a winch at the ship to pull a hose to the buoy.

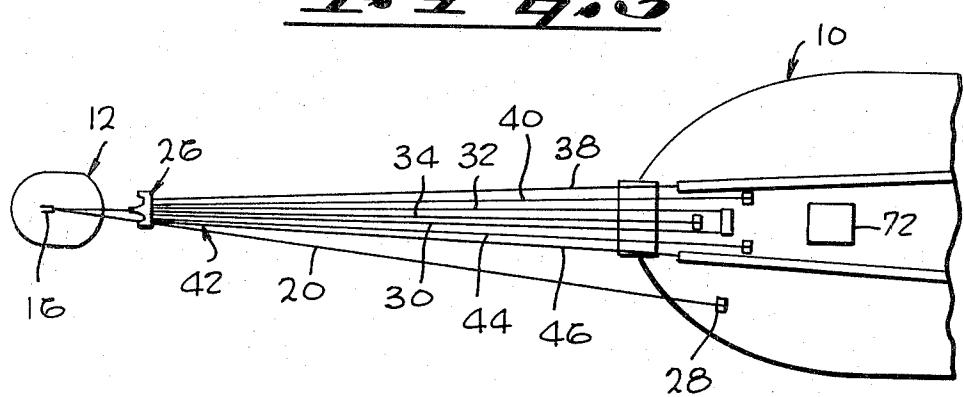
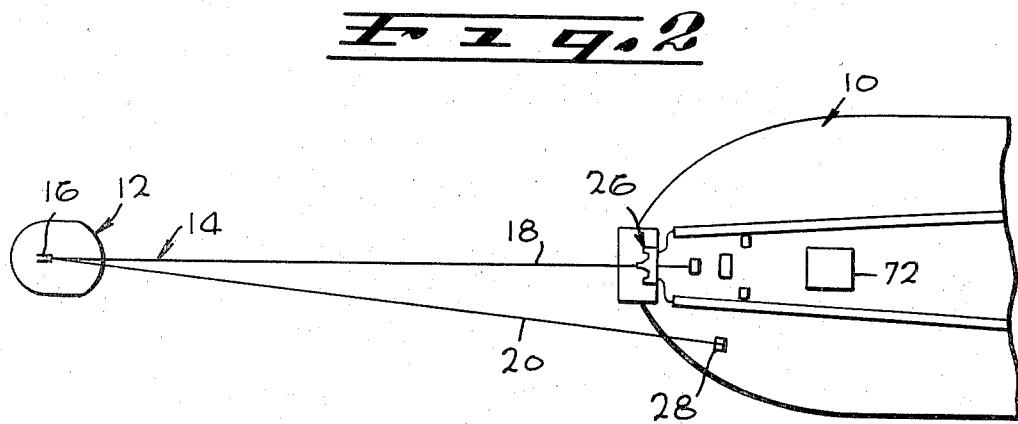
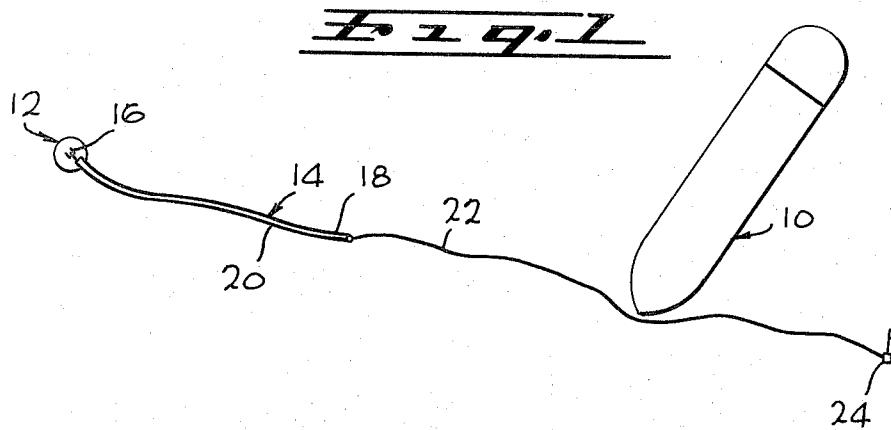
8 Claims, 13 Drawing Figures



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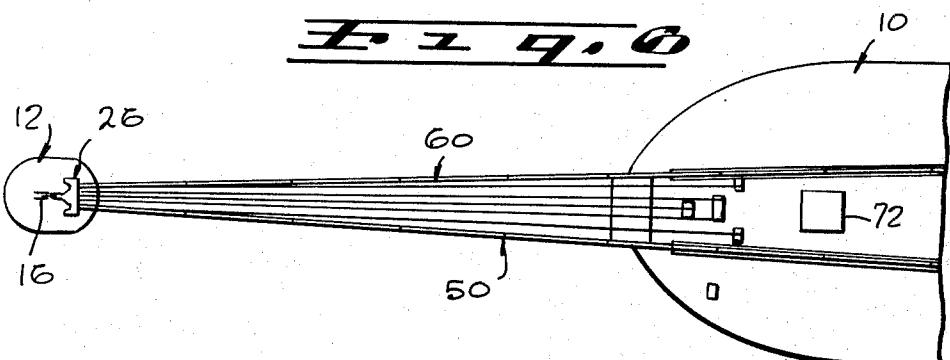
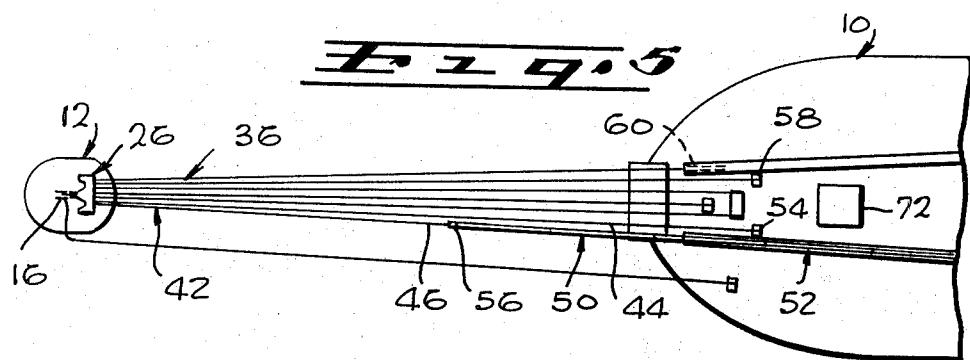
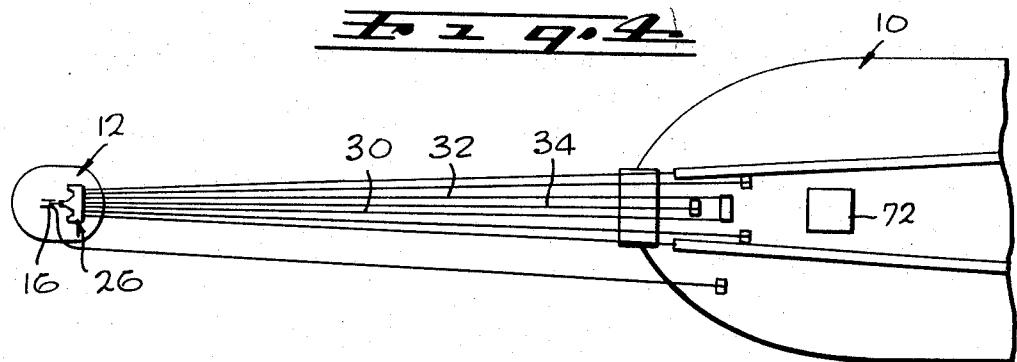
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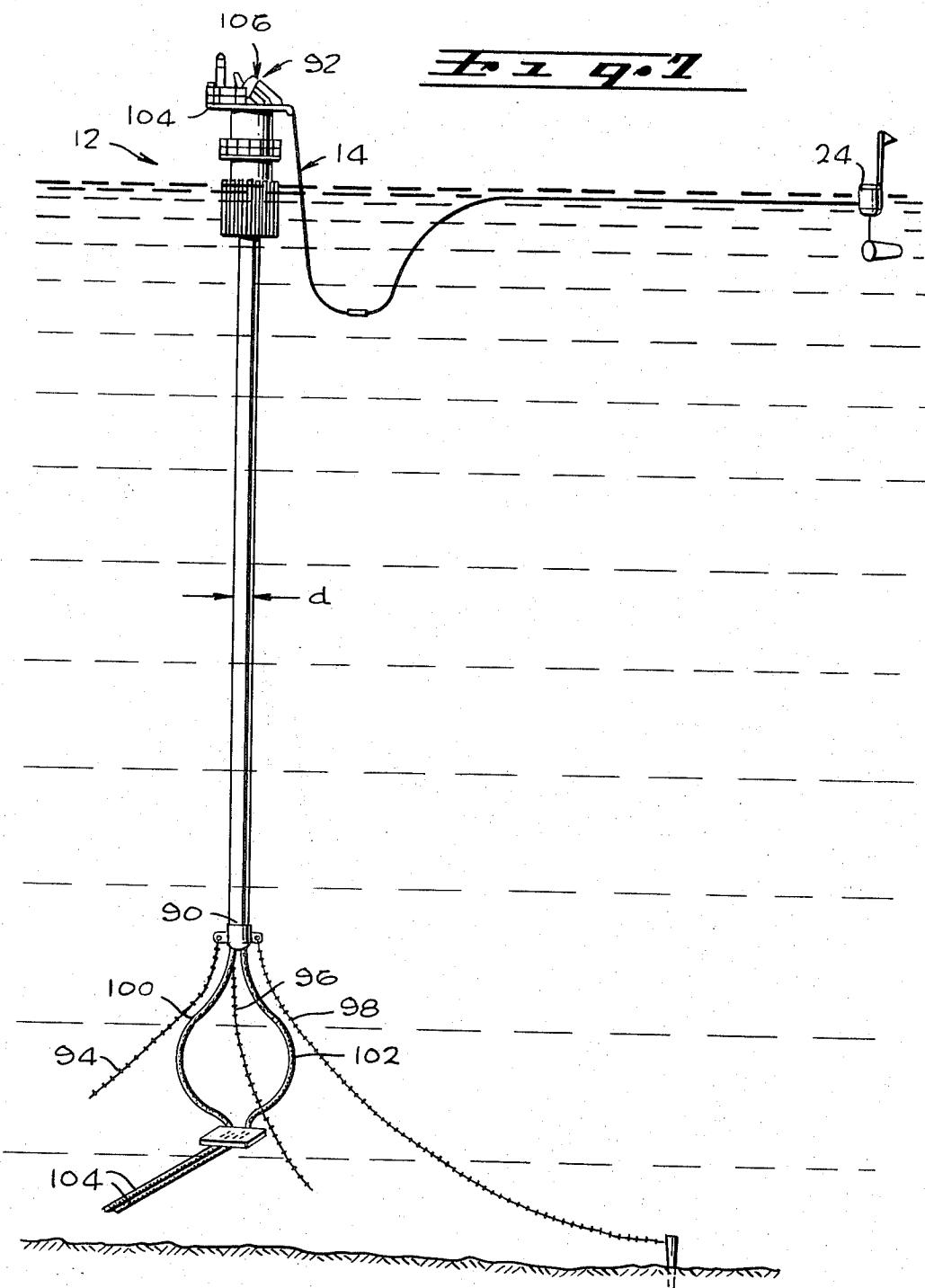
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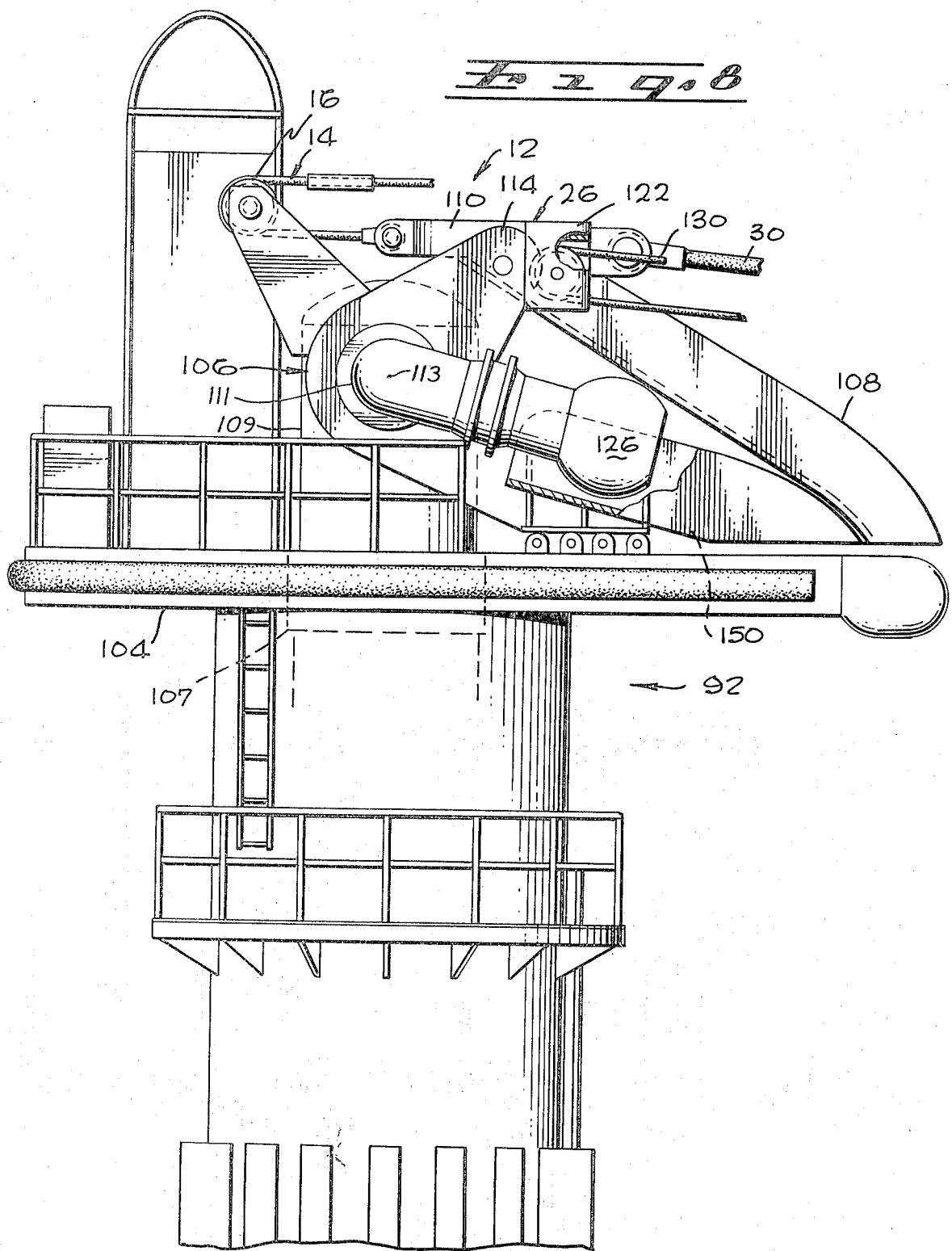
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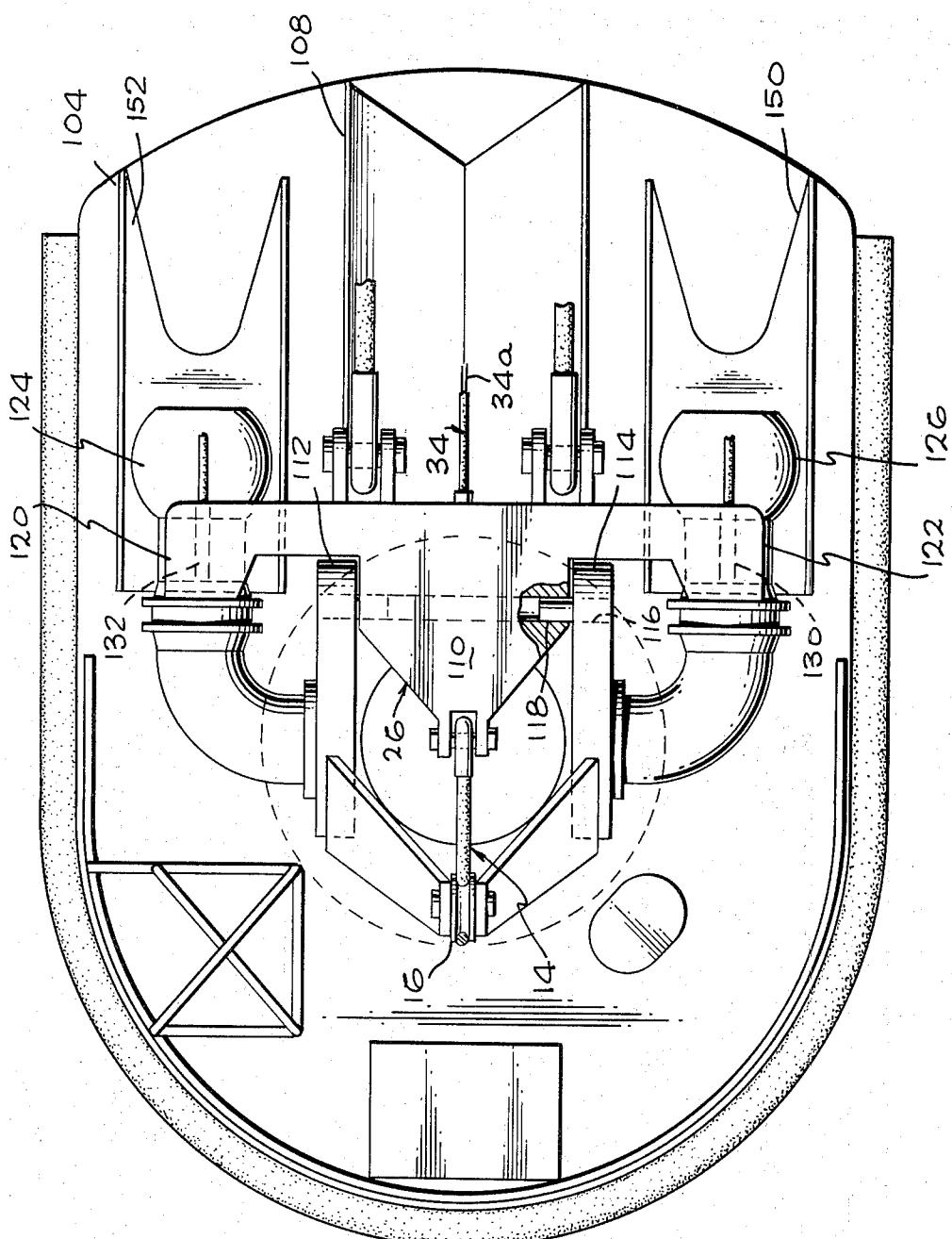


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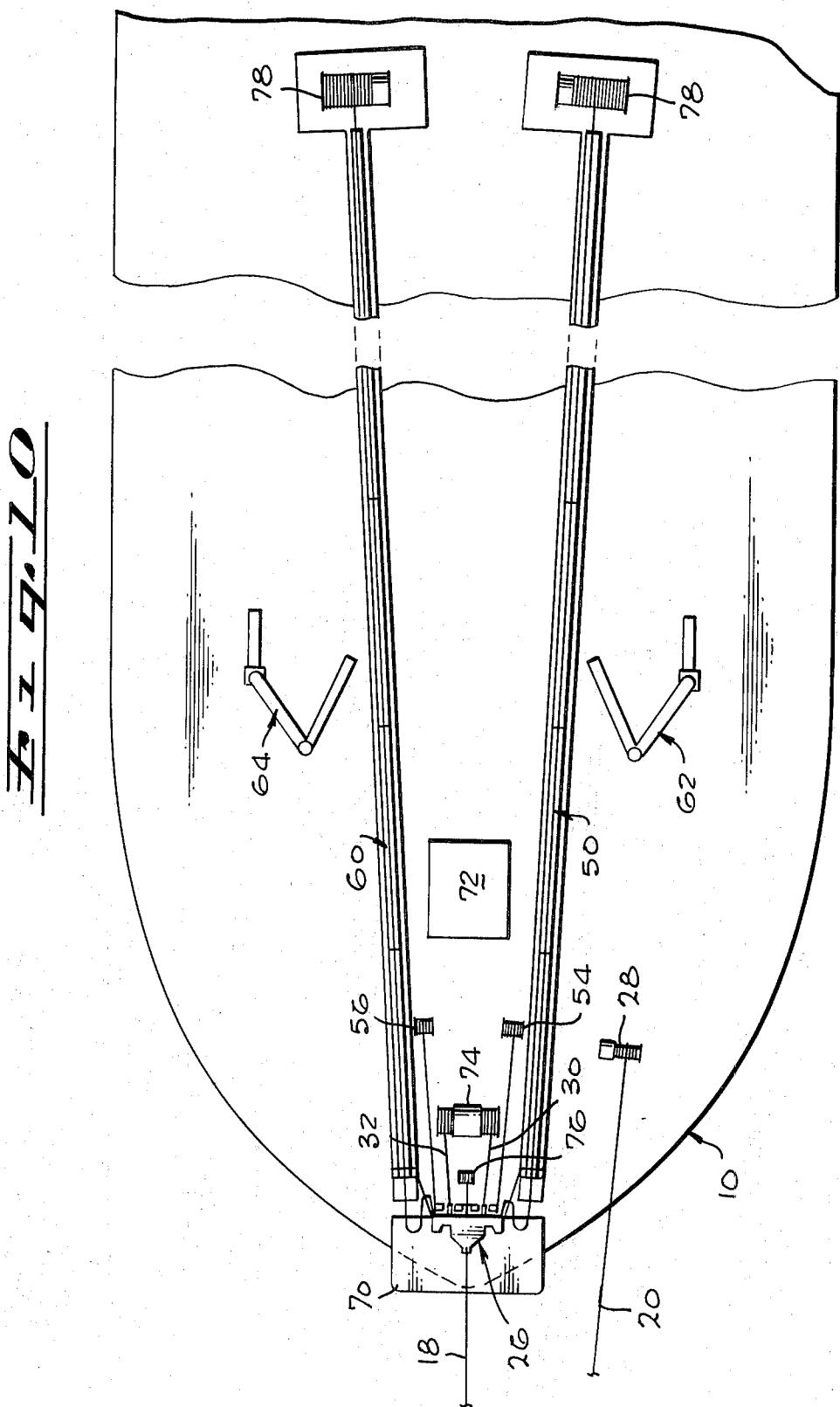
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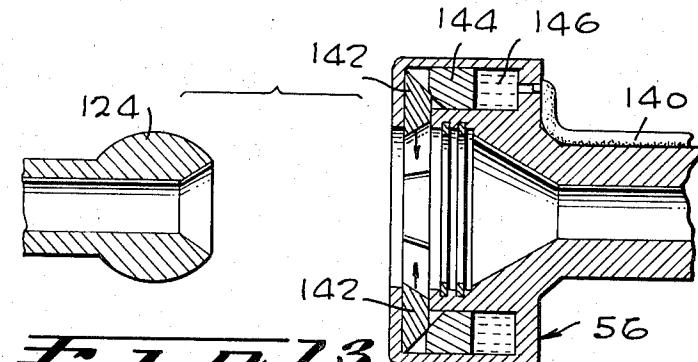
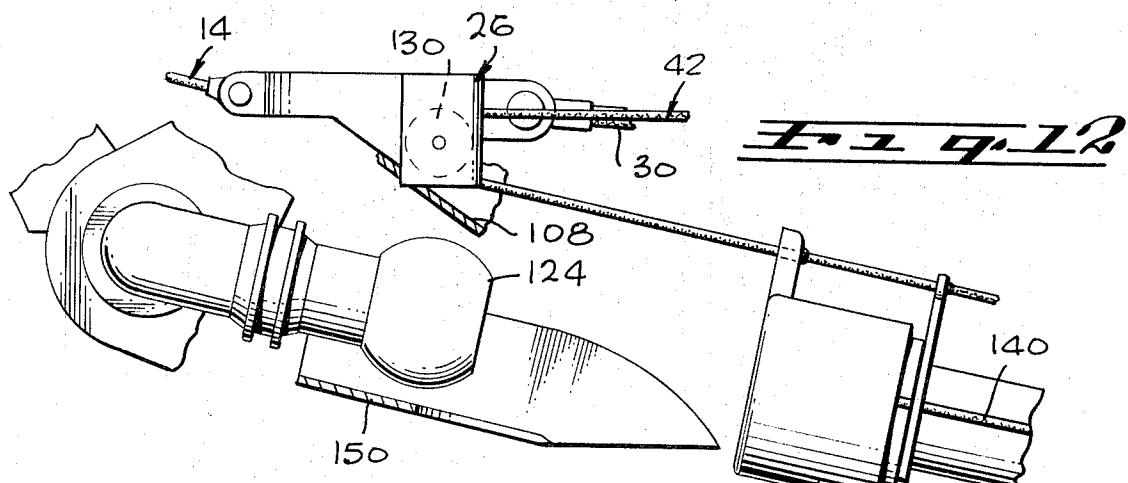
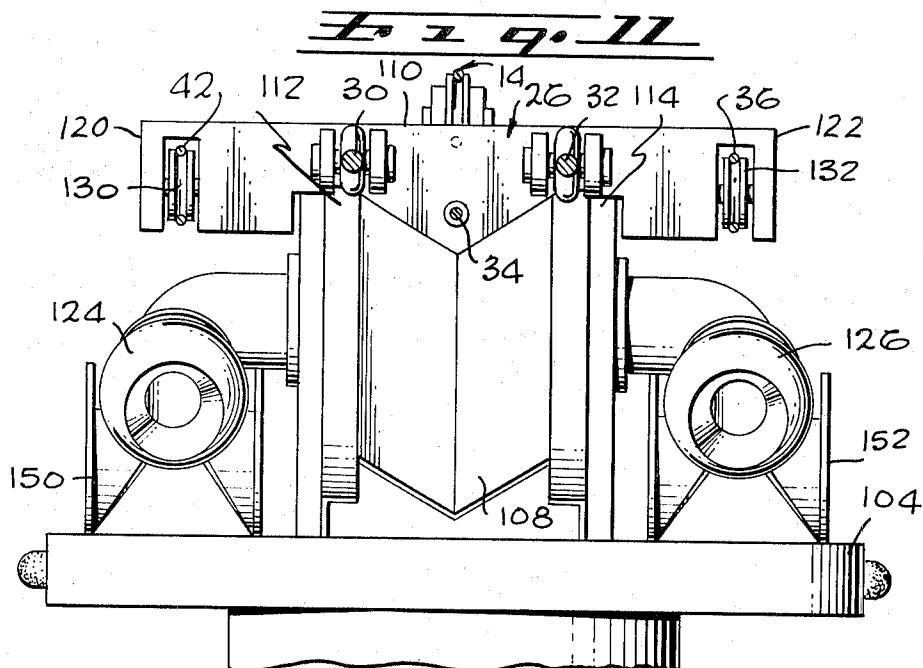
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## AUTOMATIC MOORING SYSTEM

### BACKGROUND OF THE INVENTION

This invention relates to offshore terminals and to apparatus for connecting a ship thereto.

One type of offshore loading system for transferring oil to or from a tanker ship includes a large buoy which is connected by undersea hoses to a shore-based or other installation, and which can be connected by hoses to the tanker. The running of heavy mooring lines and large hoses between the buoy and ship has heretofore often required the aid of a special service launch and the services of specialized personnel aboard such a launch. Delays can arise where service launches are not available or where the weather conditions are so poor that the launches cannot safely operate. In some areas of the world, poor weather conditions are encountered for extended periods of time, and mooring operations can be carried out only at great hazard to the personnel involved. A mooring system which could be operated without the need for personnel other than those on the ship who could remain on the ship throughout the operation, would permit moorings to be accomplished in even very bad weather.

### SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, a mooring system is provided which enables a tanker or other ship to moor to a buoy without the need for personnel other than those remaining aboard the ship. The system includes a buoy with a pulley and a hauling line extending about the pulley and having opposite ends lying in the water. A messenger line tied to the two ends of the hauling line can be picked up by a ship so that the ship gains access to the opposite ends of the hauling line. The ship has a mooring block which is attached to one end of the hauling line, and also has a hauling line winch which is connected to the other end of the hauling line. When the winch is operated to wind up the hauling line, the mooring block is pulled to the buoy and is automatically locked in place thereto. A pair of large hawser lines are pulled out from the ship with the mooring block, so that once the mooring block is secured to the buoy there are sturdy lines holding the ship to the buoy.

The mooring block contains a pair of pulleys, and a pair of hose lines extending about the pulleys are pulled out from the ship to the buoy along with the mooring block. One end portion of each hose line is connected to a hose while the other end is connected to a hose line winch. When a hose line winch is operated to pull on the hose line, the hose at the other end of the hose line is pulled from the ship to the buoy. The front end of each hose has a special fitting that is automatically engaged with a corresponding fitting at the buoy, so that the hose is automatically connected to a hose at the buoy.

The buoy, which is designed to operate in very rough seas, is of a spar buoy type, with a length many times greater than its diameter. This permits the buoy to exhibit large "elasticity" in being able to move a large distance away from its preferred central position while exerting a progressively greater force tending to return it to its original position. In making a large movement of this type, the buoy may tip considerably from the vertical. To permit continued operation during such large

movements, the top of the buoy is provided with a double swivel unit, including the usual vertical swivel that permits unlimited drifting of the ship about the buoy, and a swivel portion that pivots about a horizontal axis

5 so that the hoses can extend at a proper angle into the water regardless of large tipping of the buoy away from the vertical.

10 The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in connection with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

15 FIG. 1 is a simplified plan view of the system of the present invention, showing a first step in a mooring operation in which personnel on the ship pick up a messenger line extending from the buoy;

20 FIG. 2 is a second step in the operation, wherein the opposite ends of a hauling line extending from a buoy are respectively connected to a winch and to a mooring block on the ship;

25 FIG. 3 illustrates a third step in the operation, wherein the winch is operated to pull the mooring block to the buoy while additional lines are dragged behind the mooring block;

FIG. 4 illustrates a fourth step in the operation, wherein the mooring block is locked to the buoy;

30 FIG. 5 illustrates a fifth step in the operation, wherein a hose line winch is operated to pull a cargo hose from the ship to the buoy;

35 FIG. 6 illustrates a sixth step in the operation, wherein another hose is pulled out to the buoy, and wherein loading arms are operated to complete the hose line connection between the ship and buoy;

40 FIG. 7 is a partially perspective side view of the buoy installation of the system of the invention, shown prior to the mooring of a ship thereto;

45 FIG. 8 is a side elevation view of the upper portion of the buoy of FIG. 7, shown immediately after the locking of the mooring block thereto;

FIG. 9 is a plan view of the apparatus of FIG. 8;

50 FIG. 10 is a plan view of a portion of a ship of the system of FIG. 1, shown prior to the movement of the mooring block to the buoy;

FIG. 11 is a front elevation view of the apparatus of FIG. 8;

55 FIG. 12 is a partial side elevation view of the apparatus of FIG. 8, showing the pipe couplings being brought together; and

FIG. 13 is a sectional side view of the pipe couplings of FIG. 12.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a first step in the coupling of a tanker or other ship 10 to a buoy 12 in accordance with the present invention. A hauling line 14 is provided which has a middle portion disposed about a pulley 16 on the buoy and two opposite end portions 18, 20 which extend away from the buoy. A messenger line 22 is tied to the end portions 18, 20 of the hauling line and extends a distance out therefrom to a small marker buoy 24. The ship 10 intercepts the messenger line and hauls it aboard until personnel on the ship reach the ends 18, 20 of the hauling line.

FIG. 2 illustrates the next step in the process, wherein personnel on the ship 10 attach one end 18 of the hauling line to a mooring block 26 that is normally carried on the ship, and attach the other end 20 to a hauling line winch 28 on the ship. The winch 28 is then operated to wind up the end 20 of the hauling line, so that the block 26 is drawn towards the buoy. FIG. 3 shows the mooring block 26 at an intermediate position between the ship and buoy. It can be seen that several lines trail behind the mooring block 26 back to the ship. Among these trailing lines are two mooring hawsers 30, 32 which are heavy-duty cables designed to securely hold the ship to the buoy. A hydraulic and electric cable set 34 also trails behind the mooring block, this set 34 transmitting signals required to remotely operate mechanisms at the buoy from the ship and to transmit signals from the buoy to the ship. In addition, a starboard hose line 36 containing two end portions 38, 40 trails from one side of the mooring block and a portside hose line 42 containing two portions 44, 46 trails from the opposite side of the mooring block back to the ship.

FIG. 4 shows the mooring block 26 after it has reached the buoy 12. By means of hydraulic pulses transmitted through the hydraulic line and electrical cable set 34, locking pins are operated at the buoy 12 to securely lock the mooring block 26 in place on the buoy. Thereafter, the ship 10 is held to the buoy by the hawsers 30, 32. Hoses for carrying oil or other cargo between the ship and buoy are then moved from the ship to the buoy in the manner shown in FIG. 5. A portside hose 50 which was stored in a portside hose container 52 on the ship, is moved to the buoy 12 by a portside hose line winch 54. The winch 54 winds up one end 44 of the hose line, so that the other end 46 is drawn to the buoy and drags the hose 50 with it. The mooring block 26 has a pulley about which the hose line 42 extends, to facilitate the operation. The hose 50 has a special fitting 56 at its front end, which automatically engages a corresponding fitting on the buoy, so that as soon as the front end of the hose reaches the buoy it is automatically coupled to a conduit at the buoy. In a similar manner, another winch 58 can wind up one end of the starboard hose line 36 to move a starboard hose 60 to the buoy.

FIG. 6 illustrates the system in a condition wherein both hoses 50, 60 have been deployed to the buoy. In order to connect the hold of the ship to the hoses, a pair of loading arms 62, 64, which are connected to the hold of the ship, are swung into position for connection to the rearward ends of the hoses 50, 60. Oil or other cargo then can be transferred between the ship and the buoy, and from the buoy to any installation connected thereto.

FIG. 10 illustrates some of the additional details of the equipment normally carried by the ship 10 to help effect the coupling to the buoy. The ship is constructed with a special bow ramp 70 which is designed to guide the mooring block 26 off the ship and back onto it without damage to the ship or mooring block. A control station 72 is provided on the deck of the ship for operating the hauling winch 28, the hose line winches 54, 56, a hawser winch 74 that pays out and takes in the hawser lines 30, 32, a hydraulic and electrical cable winch 76 which pays out and rewinds the hydraulic and electric lines, and a pair of winches 78, 80 at the rear of the ship that pay out and take in ends of the hose lines.

The buoy 12 has the overall appearance illustrated in FIG. 7. The buoy 12 is of a spar buoy type, having a length between the lower end 90 thereof and the upper end 92 at least ten times greater than the average diameter of the buoy. The lower end 90 of the buoy is moored by three anchor chains 94, 96, 98 to the seabed, and is coupled by a pair of underbuoy hoses 100, 102 to underwater pipe lines 104 that extend to a shore installation or the like where cargo is to be received or to which the cargo is to be transferred. The cargo transferred to the buoy may be a fluid such as oil, or may be any other type of cargo such as a slurry that can pass through a hose. The upper end 92 of the buoy includes a rotatable platform 104 from which the hauling line 14 extends. The use of a spar buoy results in greater "elasticity" in sideward movement, or in other words, it permits the upper end of the buoy and a ship attached thereto to more readily move sidewardly under the influence of waves. In fact, the upper end of the buoy can readily move far enough so that the buoy is tilted far from the vertical and therefore the platform 104 is far from level. However, this can occur without imposing large strains on hoses that connect the buoy and ship, because the buoy is provided with a double swivel arrangement 106 that permits the hoses to extend in a wide range of directions from the buoy. That is, the conduit in the buoy includes a first swivel at 107 (FIG. 8) which permits rotation of the upper conduit portion 109 about a nominally vertical axis, and a second swivel 111 which permits rotation about a nominally horizontal axis 113. Thus, even if the spar buoy is tipped by a large angle away from the vertical, a hose connected to a buoy coupling such as 126 can still extend at a gentle incline into the water.

FIGS. 8, 9 and 11 illustrate details of the apparatus on the buoy for making connections. The rotatable platform 104 is constructed with a mooring block guide 108 in the form of a ramp, for guiding the mooring block 26 so that it is received in a predetermined position on the buoy, with a middle portion 110 of the block 26 received between a pair of plates 112, 114 on the buoy. The plates 112, 114 each have pin-receiving holes 116 (FIG. 9) for receiving pins 118 that can lock the mooring block in place. A hydraulic actuating mechanism (not shown) in the mooring block 26 can move the pins 118 outwardly into the holes 116 after the mooring block has reached the buoy, to securely lock the buoy into position. Among the set of lines 34 extending from the mooring block 26 to the ship is a hydraulic line 34a which carries pressurized oil to supply the power for moving the pins out and to move the pins back in when the ship later frees itself from the buoy.

The mooring block 26 has a pair of arms 120, 122 which lie over different pipe couplings 124, 126 (FIG. 11) when the mooring block is locked in place on the buoy. The mooring block carries a hose line pulley 130, 132 in each of these arms to guide a different one of the hose lines 42, 36, so that the corresponding hose line extends a small distance above a corresponding pipe coupling 124, 126. A connection is made between a coupling such as 124 and a coupling 56 at the front end of a hose such as 50, in the manner shown in FIG. 12. The coupling 124 on the buoy is in the form of a ball while the coupling 56 on the hose is in the form of a socket which receives the ball 124 when pressed against it. After the ball coupling 124 is inserted in the socket coupling 56, ball retainers in the socket cou-

pling 56 are closed to retain the ball in place and complete the connection. A hydraulic line 140 which runs along the hose line 50 to a hydraulic source on the ship controls operation of the ball retainer. The ball and socket type coupling is well known in the underwater pipeline field. However, an illustration of such a coupling is shown in FIG. 13, wherein the socket coupling 56 is shown to include several ball retainers 142 which can be slid radially inwardly after the ball 124 has been inserted into the socket, to lock the ball 124 in place. The ball retainers 142 are moved by pistons 144 when a high hydraulic pressure is applied in a chamber 146 behind the piston. The chamber pressure is raised by hydraulic pressure received over the hydraulic line 140. The ball 124 can be withdrawn by first removing the pressure on line 140, so that when the couplings 124, 156 are pulled apart the ball retainers 142 are easily moved outwardly to release the ball coupling. 10 15

Both of the buoy hose couplings 124, 126 can be connected in the manner described above to respective 20 hoses from the ship. A ramp 150, 152 (FIG. 11) is provided below each buoy coupling 124, 126 to help guide the forward ends of the hoses into registration with the ball couplings.

Thus, the invention provides a system which permits 25 the mooring of a ship to a buoy or other offshore installation, and the making of hose line connections between the ship and installation, utilizing only personnel on the ship. This eliminates the need for special tenders and the delay and expense associated therewith, and 30 also permits connections and disconnections to be made under adverse weather conditions when it may be dangerous for personnel to work at the buoy or alongside the ship. This is accomplished by providing a hauling line extending from the buoy, which can be picked 35 up by a ship and which is used to transfer a mooring block from the ship to the buoy. The mooring block, in turn, carries mooring hawsers to the buoy and also provides means for transferring hoses from the ship to the buoy and making connections at the buoy. Actually, 40 once strong connections are made between the buoy and ship, as at the time when the mooring block is locked to the buoy so that the buoy is connected by hawser lines to the ship, a variety of devices may be utilized to make hose connections. For example, it is possible to utilize devices that can crawl along the hawser 45 lines from the ship to the buoy to carry hoses. However, a simple movement of hoses is accomplished by utilizing pulleys on the mooring block so that hose lines which drag hoses with them, can be moved from the ship to the buoy. Because of the fact that the system is designed to eliminate the need for personnel at the buoy, a maximum number of operating mechanisms is carried by the ship, rather than at the buoy. Thus, the 50 cargo hoses which are normally permanently attached to a buoy, are here carried by the ship along with the more complicated part of the hose couplings and the apparatus that locks the mooring block in place. This has the added advantage of minimizing the possibility 55 of damage to these parts if they remain unintended in rough seas, and also facilitates check out and the making of repairs. The coupling of a ship to a buoy in very rough seas is facilitated by the use of a spar buoy with a dual swivel at the top, which permits hoses to lead off 60 in a wide variety of directions from the buoy. 65

Although particular embodiments of the invention have been described and illustrated herein, it is recog-

nized that modifications and equivalents may readily occur to those skilled in the art and consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for mooring a ship to a buoy or other offshore installation, comprising:

pulley means mounted on the offshore installation; a hauling line extending about the pulley means and having a pair of opposite ends normally lying in the water;

a mooring block mounted on the ship and attachable to one of said ends of said hauling line; a haul-line winch mounted on the ship, for pulling on another of said ends of said hauling line so that the mooring block is pulled to the offshore installation; at least one second line stored on the ship and attached to the mooring block so that it is pulled to the offshore installation with said mooring block; and

means for locking the mooring block securely to the offshore installation

2. The apparatus described in claim 1 wherein:

said second line includes at least one hose line, said mooring block includes a hosesline pulley, and said hose line has first and second ends at the ship and a middle portion which extends from the ship around the hosesline pulley and back to the ship; and including

a hosesline winch mounted on the ship and engaged with the second end of the hose line; a cargo hose normally mounted on the ship and engageable with an end portion of the hose line nearest said first end thereof, so that after the block is secured at the offshore installation and the hosesline winch is operated to pull the second end of the hose line, the hose moves towards the block at the offshore installation;

a conduit extending to said offshore installation; a first hose coupling connected to the conduit; and a second coupling mounted at an end of the cargo hose for engaging the first coupling when the hose end reaches the offshore installation.

3. The apparatus described in claim 1 including:

a messenger line normally lying in the water and having one end tied to the opposite ends of the hauling line and a second end, and a marker buoy tied to the second end of the messenger line.

4. The apparatus described in claim 1 including:

a ramp mounted at the offshore installation for guiding the mooring block along an upward incline along its last movement prior to locking in position.

5. A method for mooring a ship to a buoy comprising: maintaining a hauling line in extension about a pulley at the buoy;

lifting the ends of the hauling line onto the ship and tying a first end of the hauling line to a winch on the ship and a second end to a mooring block on the ship;

operating the winch to pull the first end of the hauling line, so that the second end with the mooring block thereon moves to the buoy;

tying a hawser line to the mooring block prior to operating the winch, so that an end of the hawser line is brought to the buoy with the mooring block; and

securely locking the mooring block to the buoy, to thereby securely couple an end of the hawser line to the buoy.

6. The method described in claim 5 including: extending a hose line about pulley means on the mooring block while the mooring block is on the ship, and tying a first end of the hose line to a hose line winch on the ship and a second end to a cargo hose on the ship; and operating the hose winch after the mooring block has reached the buoy, to wind up the first end of the hose line so that the second end and the hose tied thereto moves from the ship to the buoy.

7. In a mooring system wherein a ship picks up the ends of a hauling line that extends about a pulley on a buoy, so that the ship can transfer a second line to the buoy by tying one end of the second line to an end of the hauling line and pulling in the other end of the hauling line, the improvement comprising:

a mooring block on the ship, said block having a hosesline pulley thereon; a hose line having opposite ends on the ship and extending about the hosesline pulley on the block;

8. a hose disposed on the ship and attached to a first end portion of the hose line; a hauling line winch disposed on the ship for pulling one end of the hauling line while the other end of the hauling line is attached to the mooring block, to pull the block to the buoy; and a hose line winch disposed on the ship and engaged with a second end portion of the hose line which is opposite the first end portion, whereby when the mooring block is moved to the buoy and the hose-line winch is operated, the first end of the hose line and the hose attached thereto are pulled to the buoy.

8. The improvement described in claim 7 including: a buoy having a hose coupling, means for attaching the buoy to said mooring block, and a pulley; a hauling line extending about the pulley on the buoy; and a messenger line tied to the opposite ends of the hauling line, said messenger line lying in the water to facilitate its pickup by a ship.

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