United States Patent [19]

Lehrer

[11] **3,828,683**

[45] **Aug. 13, 1974**

[54] **MARINE LOAD TRANSFER SYSTEM**

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[22] Filed: **Dec. 4, 1972**

[21] Appl. No.: **311,546**

[52] **U.S. Cl.** **104/114,** 212/72, 212/84, 212/89, 214/12, 214/13, 214/14, 254/172

[51] **Int. Cl.** **B65g 67/58**

[58] **Field of Search** 104/114; 212/72, 84, 89; 214/13–14; 254/172

[56] **References Cited**

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3,217,660	11/1965	Schillinger	214/13 X
3,312,452	4/1967	Butler et al.	254/172
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FOREIGN PATENTS OR APPLICATIONS

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1,012,755	12/1965	Great Britain	254/172
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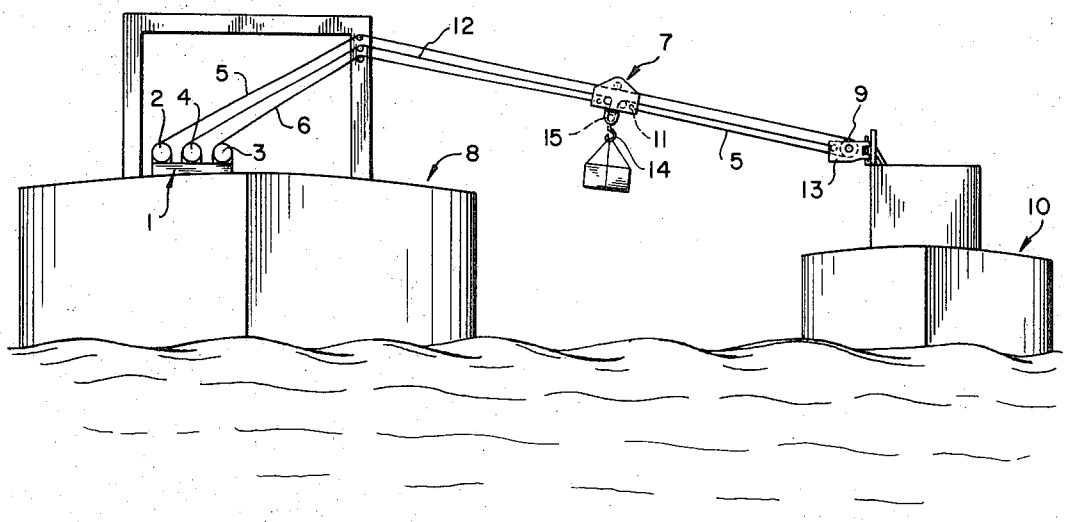
Assistant Examiner—R. B. Johnson, Sr.
Attorney, Agent, or Firm—Richard Wiener

[57] **ABSTRACT**

This system for transfer of a load at sea includes a three-drum winch that controls three lines, a set of sheaves mounted on a kingpost or mast on the supply ship, a block to be mounted to a padeye on the receiving ship, and a trolley that rides the lines between ships and raises, lowers and transports the load. The lines are maintained under relatively constant tension, responsive to motion of ships.

3 Claims, 3 Drawing Figures



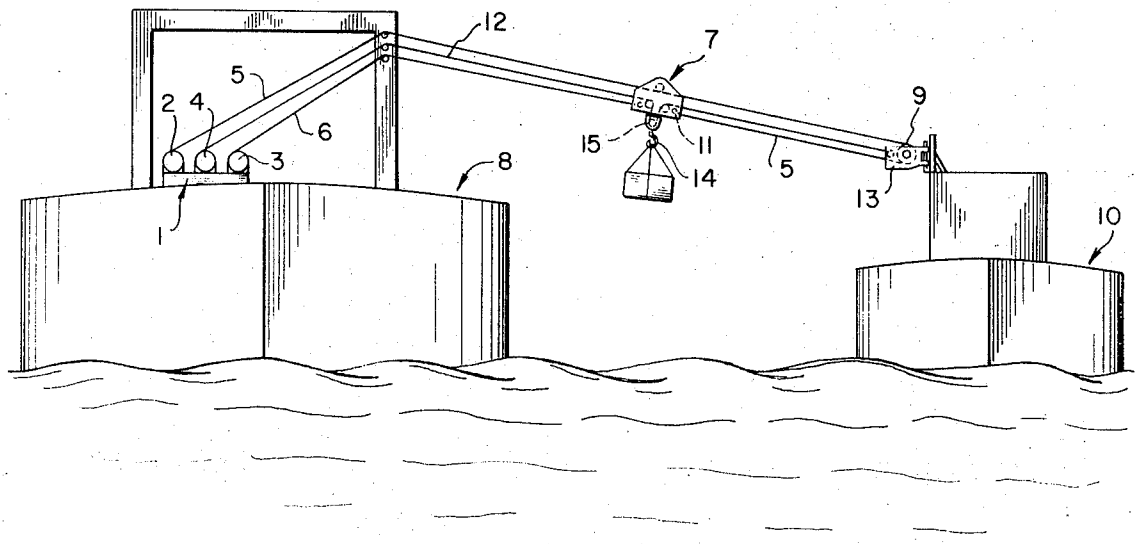


FIG. 1

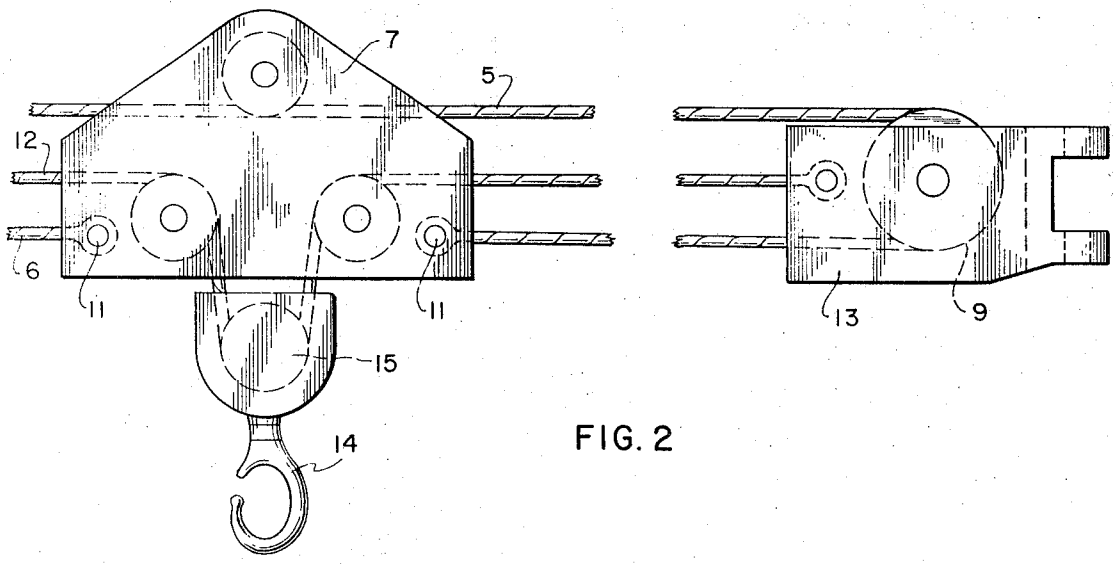


FIG. 2

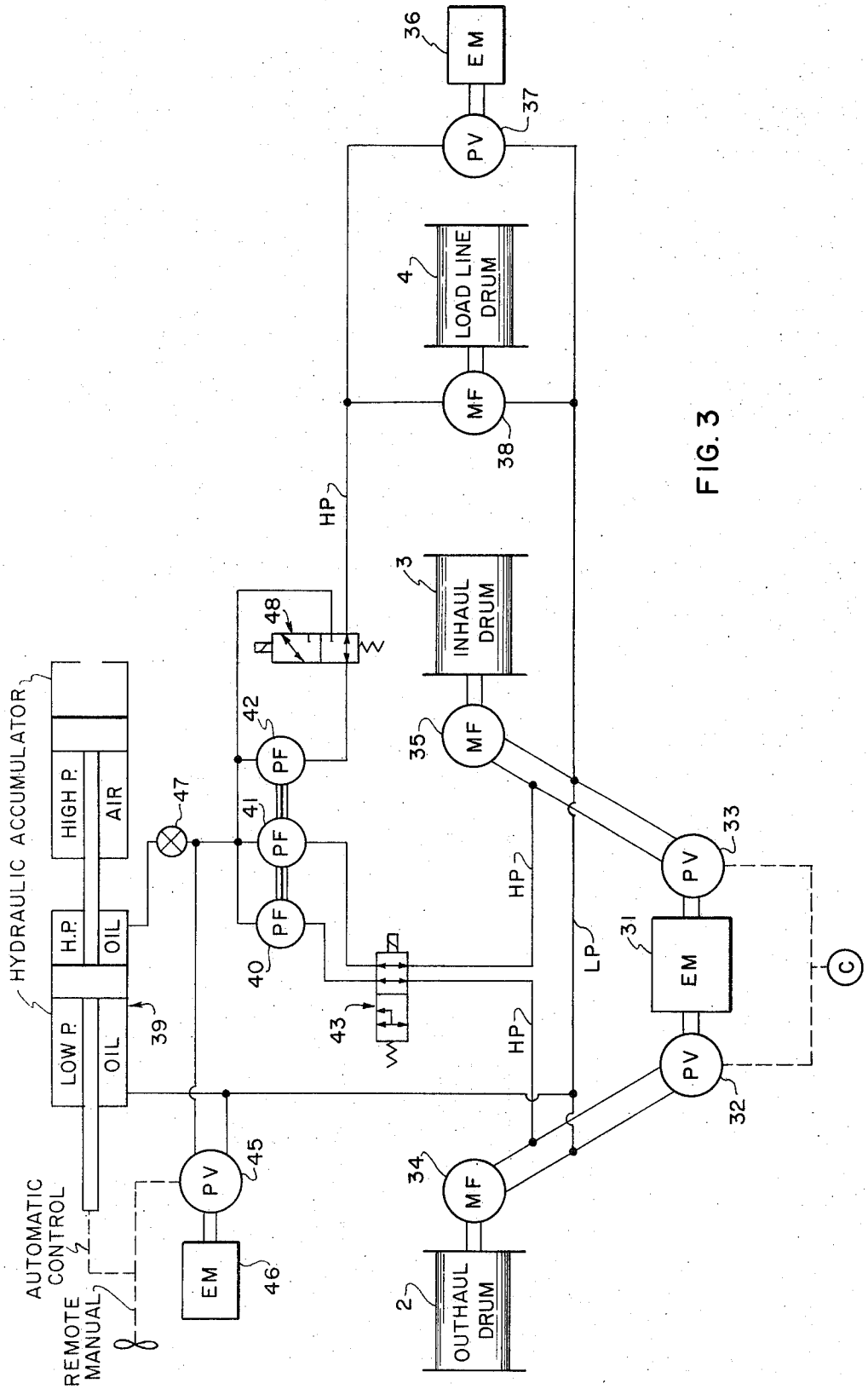

HYDRAULIC ACCUMULATOR
HIGH P.
AIR
H.P.
OIL
LOW P.
OIL
AUTOMATIC CONTROL
REMOTE MANUAL
EM
PV
MF
PF
LOAD LINE DRUM
INHAUL DRUM
OUTHAUL DRUM
HP
LP
C

FIG. 3

MARINE LOAD TRANSFER SYSTEM

BACKGROUND OF THE INVENTION

Heretofore, underway replenishing ships were built with a ship-to-ship cargo handling system (known as FAST), consisting of (a) a wire rope highline between ships; (b) a trolley riding the highline; (c) a double kingpost and sliding block which raises and lowers the highline and trolley receiver on the supply ship; (d) a highline winch and a ram tensioner to tend the highline; (e) inhaul and outhaul winches to move and control the trolley; (f) a receiver to catch the trolley, remove the loaded strongback therefrom and lower it to the deck of the receiving ship; (g) an elevator on the supply ship to raise the loaded strongback and latch it to the trolley; and (h) an automatic below-decks handling system on the supply ship.

This system proved to be excessively complex for maintenance by ship's personnel. It required control of speed and position of the trolley under conditions of ship motion by means of tension and speed sensors, and hydraulic or electronic controls. To reduce this complexity somewhat, components (f), (g) and (h) were eliminated. Automatic latching to the trolley was replaced by manually hanging a sling on a cargo hook. A sliding padeye was provided to lower the rig on the receiving ship, or a controlled lowering device (drop reel) was used with the trolley. This system (known as STREAM) requires a sliding padeye on the receiving ship, and uses the tensional operation of the hauling winches with their sensors and controls.

Unfortunately, the STREAM system is subject to many of the problems that beset the FAST system. As a result, ships are frequently operated using the World War II conventional "housefall rig".

The housefall rig uses two winches under speed control, with both winch lines being connected to a single load hook. One line is led through a block on the supply ship kingpost, the other through a block attached to a high padeye on the receiving ship. Hoisting, traverse and lowering of the load, and response to ship motion, are all accomplished by manual control of the two winches. Quite obviously, use of the housefall rig is limited with respect to speed, carrying capacity, ship separation and ship motion, and thus represents an unsatisfactory way of avoiding the drawbacks of the FAST and STREAM systems.

The system described in my U.S. Pat. No. 3,654,869, dated Apr. 11, 1972, is a partial solution to the problems mentioned. It employs a differential geared winch and a ram tensioner to provide the hauling and tensioning features. A sliding block and sliding padeye are required to raise and lower loads.

U.S. Pat. No. 3,217,660, dated Nov. 16, 1965, also provides for a tensioned rig, but does not replace the sliding block, sliding padeye, or sensing and control system.

U.S. Pat. No. 2,942,740, dated June 28, 1960, provides for a tensioned high line and a load line for hoisting and lowering the load. However, it requires two hauling winches with their control systems. A massive counterweight operating in an elevator shaft inside an enlarged kingpost is used to provide rig tension. Trial of this system revealed problems in operation, in addition to those of weight and cost.

U.S. Pat. No. 3,012,518, dated Dec. 12, 1961, uses a counterweight for tensioning a high line and a load line, while U.S. Pat. No. 3,388,070, dated June 11, 1968, discloses a highline system using a ram tensioner.

The present invention is intended to overcome the disadvantages of the earlier systems, and to permit operation in situations involving heavy seas and relatively large ship separations. Auxiliary machinery, such as a sliding block on the supply ship or a sliding padeye on the receiving ship, is not required, and tension in the rigging is provided by the inherent characteristics of the machinery, without dependence on tension sensing and servo-mechanism loops.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a system for transferring cargo between two ships at sea. The system comprises a winch means including three drums, and a tensioned rigging arrangement permitting operation in heavy seas and in circumstances of relatively large ship separation.

Two of the winch drums tend two lines called the out-haul and the in-haul. These lines, which support the cargo-carrying trolley and haul it from ship to ship, are kept under relatively constant tension during operation of the system. The third drum tends a line called the load line. This line passes through the trolley and is secured at the receiving ship block. To lower the load, line is payed out on the third drum.

The winch does the work of hauling the trolley, providing tension to support the trolley and load, and operating the load line. When the ships move relative to each other, the winch pays out or hauls in line on all three drums to maintain a relatively constant tension, the length of the load line remaining equal to the length of the loop formed by the hauling lines.

The controls for operating the winch are extremely simple, requiring only one man, and are arranged to minimize the possibility of error. There are two control levers, one for trolley travel and the other for hoisting and lowering the load.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention is shown in the accompanying drawings, in which like reference numerals indicate like parts, and in which:

FIG. 1 is a schematic front elevation of the rigging arrangement in its relation to the supply and receiving ships;

FIG. 2 is a detail of the arrangement shown in FIG. 1, illustrating the relationship of the out-haul, the in-haul and the load line; and

FIG. 3 is a diagram of the hydraulic system of the three-drum winch.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Before describing the components of the system, it will be useful to explain what the system does and how its components function.

Winch 1 comprises three winch drums 2, 3 and 4. Winch drums 2 and 3 tend two hauling lines 5 and 6, called the out-haul and the in-haul, respectively. These lines haul the trolley 7 from ship to ship, and also support the trolley.

Lines 5 and 6 are kept under relatively constant tension during operation of the system. Out-haul 5 comes from the supply ship 8 over a pulley mounted on the kingpost or mast and passes through the trolley. It then passes around a sheave 9 on the receiving ship 10, and its end is secured to the outboard end of the trolley. The inhaul line 6 goes from the supply ship 8 over a pulley mounted on the kingpost or mast directly to a securing point 11 on the trolley.

The third drum 4 tends a line 12 called a load line. This line passes over a pulley mounted on the kingpost or mast through the trolley 7 and is secured at the receiving ship block 13. The load hook 14 is attached to a single sheave block 15 that rides in a bight of the load line 12 below the trolley 7. To lower the load, line is paid out on drum 4. Similarly, to hoist the loaded hook 14, line is hauled in. During transit the load line 12 runs through the trolley 7 and the block 15 supporting the hook 14.

The winch 1 does the work of hauling the trolley 7, providing tension to support the trolley and load and operating the load line 12. When the ships move relative to each other, the winch 1 pays out or hauls in line on all three drums to maintain relatively constant tension. The length of the load line 12 remains equal to the length of the loop formed by the hauling lines 5 and 6. Thus, in transit, the separation between the trolley 7 and the hook block 15 remains constant, and the transit may be made with the hook 14 in the two-block position.

In order to facilitate handling the load on each ship, the winch 1 controls the speed and position of the trolley 7 relative to that ship. When the trolley is stopped at the receiving ship 10, it stays at a fixed distance from the attachment point on that ship, and when it moves, it is relative to that fixed position. Similarly, when the trolley is at the supply ship 8, it moves or stops relative to the supply ship.

To accomplish this performance, the winch 1 responds to ship motion by paying out or hauling in equal lengths of wire rope on all three drums 2, 3 and 4 when the trolley 7 is near the receiving ship 10.

When the trolley is near the supply ship 8, the in-haul line 6 stops when the trolley is to be stopped, holding it at a fixed position from the supply ship. When the trolley is moved, the in-haul 6 moves with desired motion relative to the supply ship. In this situation, only the out-haul 5 and the load line 12 respond to ship motion.

A control station suitable for one-man operation is provided for the system. It includes two control levers, one for trolley travel and one for hoisting and lowering the load. The controls are arranged to minimize the possiblity of error. The control station also has remote starting switches for the electric motors.

The rig is connected to the receiving ship in the following manner. As the receiving ship approaches the supply ship, heaving line is passed. A manila messenger is hauled aboard the receiving ship 10, and is attached to a block that carries a bite of a second messenger. This block is pinned to a padeye on the receiving ship, located above the main padeye. One end of the second messenger is attached to the receiving ship block shown in FIG. 2. The other end is handled by a gypsy on the supply ship 8. The receiving ship block carries the out-haul line 5 and the load line 12. When this block comes aboard the receiving ship, it is pinned to the main replenishing padeye, and the system is connected. The rig is then tensioned and is ready for operation.

Return of the rig is similar.

The hydraulic system illustrated by FIG. 3 operates as follows:

The electric motor 31 provides the power for the trolley hauling function. This motor drives two variable stroke hydraulic pumps 32 and 33. Pump 32 is connected to drive hydraulic motor 34, while pump 33 is connected to drive hydraulic motor 35. The output of the two pumps is controlled by a common control circuit so that the two pumps are stroked equally in opposite directions. This arrangement causes one of drums 2 and 3 to haul in cable when the other pays out cable.

An electric motor 36 drives variable stroke hydraulic pump 37. Control of the stroke of this pump in turn controls the speed and direction of hydraulic motor 38 and the load line drum 4. This permits raising and lowering the load independently of the trolley hauling system.

Tensioning of the rig is achieved by supplying high pressure hydraulic fluid to the hauling-in side of each of the three hydraulic motors 34, 35 and 38. The high pressure fluid is supplied by an hydraulic accumulator 39.

When the trolley 7 is located near the receiving ship 10, it is necessary that all three drums 2, 3 and 4 respond equally to ship motion. This will cause all three drums to pay out or haul in equal lengths of line. This is the condition needed to phase the trolley motion relative to the receiving ship and to keep the height of the load hook 14 constant.

When the trolley 7 is near the supply ship 8, it is necessary for the in-haul drum 3 to respond only to the trolley control. All accommodation to ship motion must be by the out-haul drum 2. The load line drum 4 must still accommodate ship motion, but since the out-haul drum 2 must supply enough cable for both the upper and lower legs of the out-haul line 5, it must respond at twice the speed of the load line 12 in order to maintain the load hook 14 at constant height.

The metering of flow to produce these required conditions is accomplished by pumps 40, 41 and 42, and by valve 43.

The three pumps are mechanically connected so that they all rotate together. There is no motor or load connected to them. Thus, if pressure is reduced on the winch side, they will rotate freely and deliver equal volumes to the three motors, causing the three drums to haul in equal lengths of cable. Similarly, if ship motion draws cable off the drums, the fluid will be returned to the accumulator equally from each motor. Valve 43 provides for phasing motion of the trolley 7 to the supply ship 8. When the valve 43 is in the position shown, one of pumps 40, 41 and 42 supplies each of the hydraulic motors 34, 35 and 38. When the valve is in the other position, pumps 40 and 41 both supply the motor on the out-haul drum 2. This provides the double speed relative to the load line 12. The motor on the in-haul drum 3 is isolated from the accumulator and is therefore independent of ship motion. This provides the trolley speed control relative to the supply ship.

The three metering pumps may have a high flow rate during ship roll, but it will be noted that normally the pressure drop or rise through the pump is small. Both

sides of each pump are in a high pressure circuit. Also, the function is such that a small internal leakage is not detrimental. For these reasons, simple gear type pumps may be used.

It will be noted that all of the tension control occurs in the high pressure lines. All the low pressure lines are interconnected, and are connected to the low pressure side of accumulator **39.**

The hydraulic accumulator (FIG. **3**) consists of two cylinders, namely, an oil cylinder and an air cylinder. The oil cylinder has a piston with two piston rods, one of which also serves as a piston rod for the air cylinder. The compressed air exerts a force on the piston in the air cylinder. This force is transmitted to the hydraulic cylinder piston through the common piston rod. The hydraulic cylinder piston then pressurizes the oil in the right hand of the cylinder.

It should be explained that two piston rods are provided in the oil cylinder so as to keep the total volume of the piston constant while the piston moves, thus permitting use of the accumulator in a closed hydraulic system.

Since the compressed air cannot come into contact with the fluid of the accumulator, there is no danger of forming an explosive mixture. For this reason, there is no need to use special non-flammable fluid. Rather, petroleum base oil can be used.

The capacity of the accumulator is sufficient to accommodate any rapid changes due to ship's roll. It is not practical to make it large enough to accommodate changes in the positions of the ships. These slower changes are accommodated by the ram centering pump **45,** driven by electric motor **46.**

The ram centering pump has a control which acts automatically to center the ram, thus keeping the ram in position ready to compensate for rapid changes in ship-to-ship separation. Closing of valve **47** separates the ram from the winch circuit, whereupon pump **45** may be used to pay out line or haul in line without tension on the system, during connectup or disconnecting of the rig from the receiving ship.

Valve **48** may be provided for isolating the load line drum **4** and operating it as an independent winch. A number of relief valves, replenishing lines and drains are needed for safety and proper operation of the system, but are not essential to an understanding of the functions of the hydraulic system, and thus are not described.

What is claimed is:

1. In a system for transfer of cargo at sea between a supply ship and a receiving ship, comprising:

a winch means mounted on said supply ship including three drums and controlling three lines;

an in-haul line on the first of said drums;

an out-haul line on the second of said drums;

a load line on the third of said drums;

a load-carrying trolley adapted to be hauled by said in-haul and out-haul lines; a kingpost or mast mounted on said supply ship; a plurality of sheaves mounted on said kingpost or mast; a padeye; a receiving ship block for mounting said padeye on the receiving ship; the in-haul line running from said first drum through one of said sheaves and being attached at the inboard end of said trolley; the out-haul line running from said second drum through a second one of said sheaves, through said trolley, around a sheave on the receiving ship block, and having its other end attached to the outboard end of the trolley; the load line passing from said third drum through a third one of said sheaves through said trolley, and being secured at the receiving ship block; a hydraulic motor for each drum for driving each of the said drums, including a plurality of metering pumps for variably metering the flow of high pressure hydraulic fluid to the motors for driving each of the said three drums in accordance with the position and motion of the ships relative to each other and for keeping the total tension on the three lines relatively constant; manual controls for operating said winch means including a first control adapted to haul the trolley between ships and hold it in position relative to the proximate ships, and a second control adapted to permit raising and lowering of the load independently of the first control.

2. In the system according to claim **1,** the first said control including a first hydraulic pump for driving the first said drum, and a second hydraulic pump for driving the second said drum, the output of said hydraulic pumps being controlled so that one of the said first and second drums hauls in line when the other pays out line.

3. In the system according to claim **1,** an hydraulic accumulator connected to the three drum motors for providing tension input to the winch.

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