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Crooke et al.

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[54] **APPARATUS FOR RAISING AND LOWERING LARGE OBJECTS FROM A SURFACE SHIP**

[75] Inventors: **R. Curtis Crooke**, Corona Del Mar; **John R. Graham**, Newport Beach; **James F. McNary**, Pacific Palisades, all of Calif.

[73] Assignee: **Global Marine, Inc.**, Los Angeles, Calif.

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[52] **U.S. Cl.** ..... **214/15 R**; 114/43.5

[51] **Int. Cl.** **B63b 35/40**

[58] **Field of Search** ..... 214/15 R; 114/43.5

[56] **References Cited**

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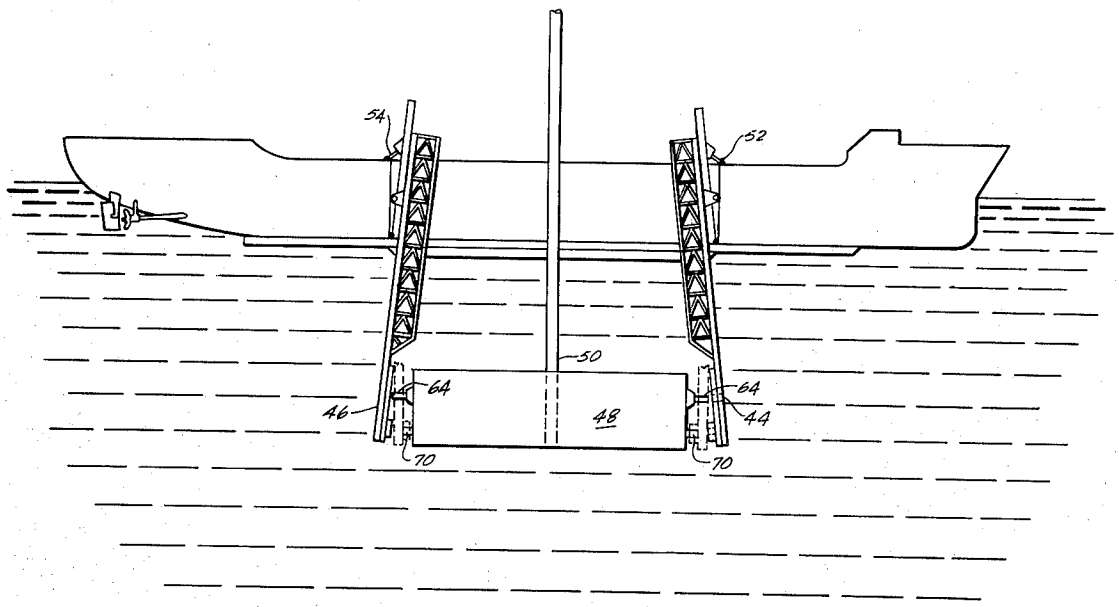
Primary Examiner—Robert J. Spar
Assistant Examiner—George F. Abraham
Attorney, Agent, or Firm—Christie, Parker & Hale

[57] **ABSTRACT**

Two vertically movable, tiltable legs, one located at the forward end and one located at the aft end of a large open well internal to the hulls of a vessel for deep ocean mining operations for docking and undocking a subsurface mining vehicle and for raising and lowering the mining vehicle into or out of the well. Each leg includes a panel at the lower end thereof for engaging pins on the mining vehicle. The panels include a keyhole slot to aid in initial capture of the mining vehicle and restrict relative motion between vessel and vehicle after capture. Each panel features a hydraulically driven slide portion to permit lateral movement of the vehicle after docking in the event such lateral movement is required to stow the vehicle or to trim the vessel with the loaded vehicle on board when the docking legs are engaged with the vehicle.

14 Claims, 5 Drawing Figures



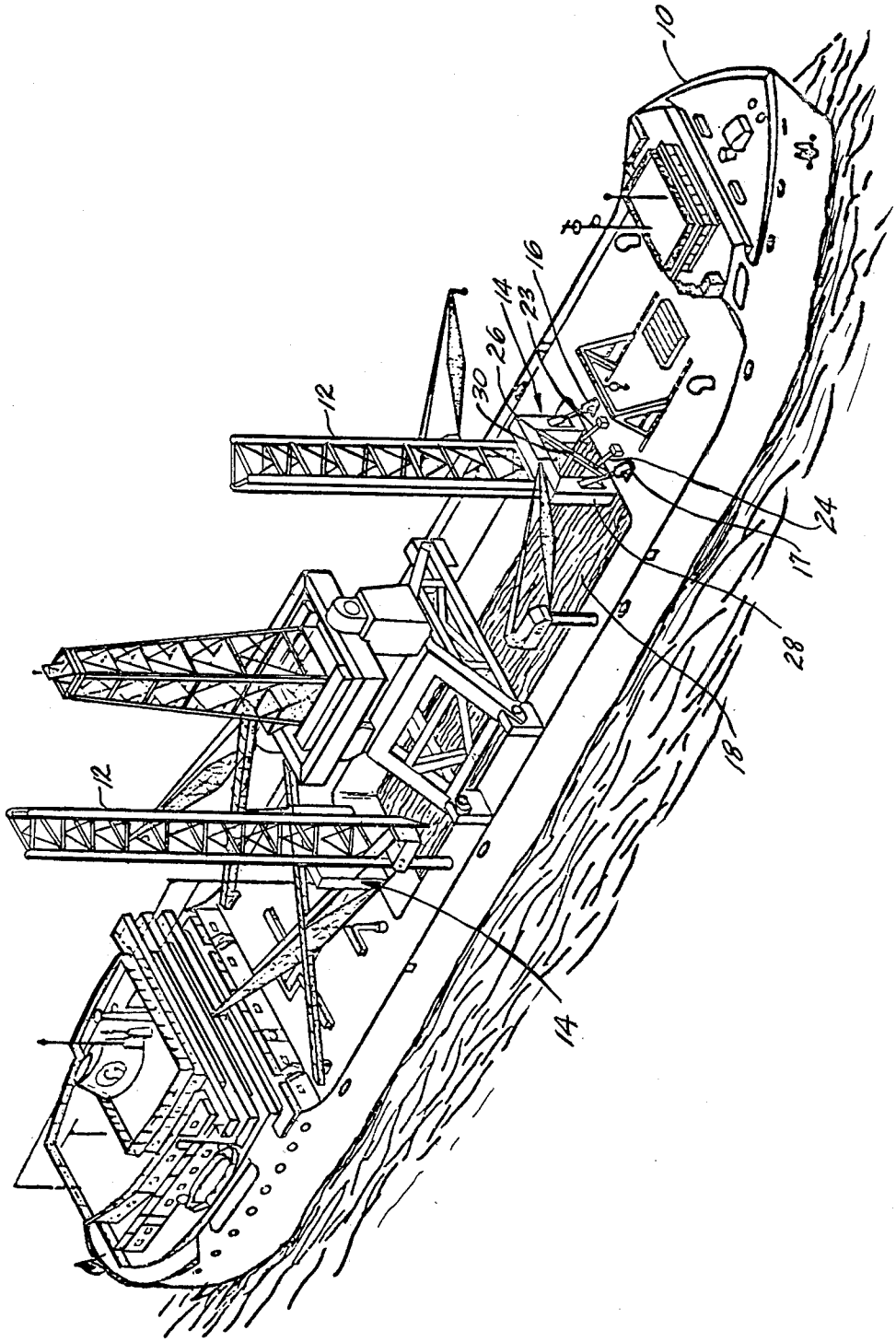


Fig. 1

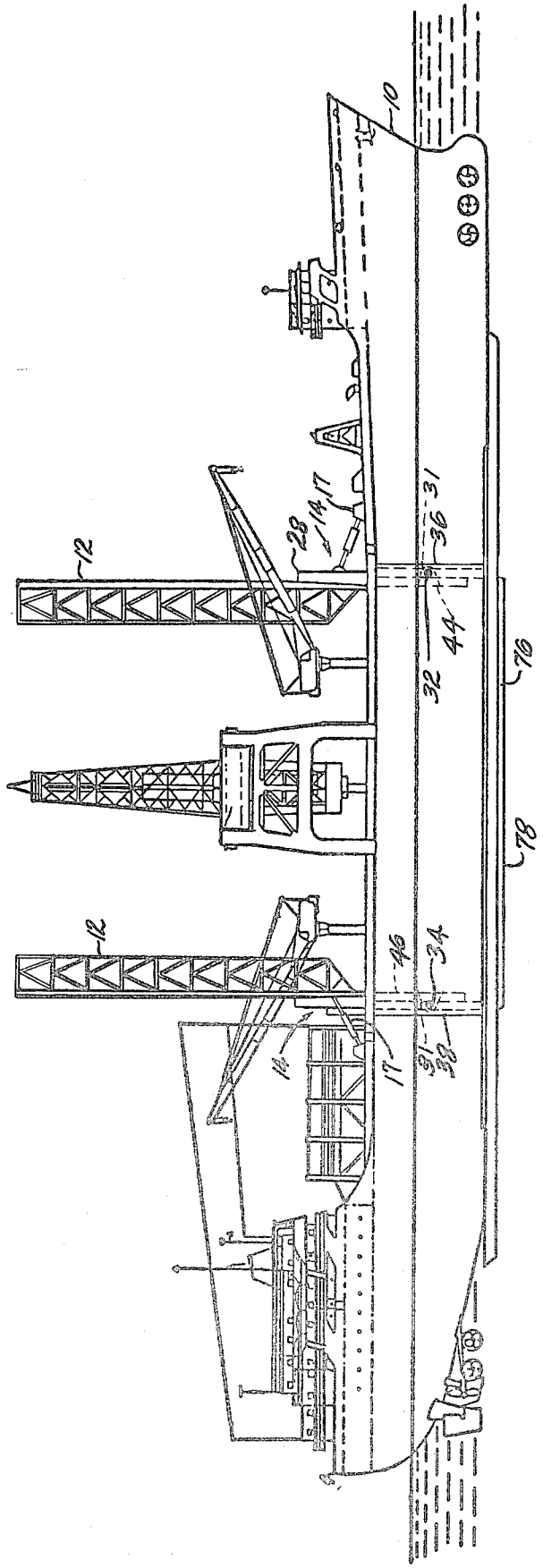


Fig. 2

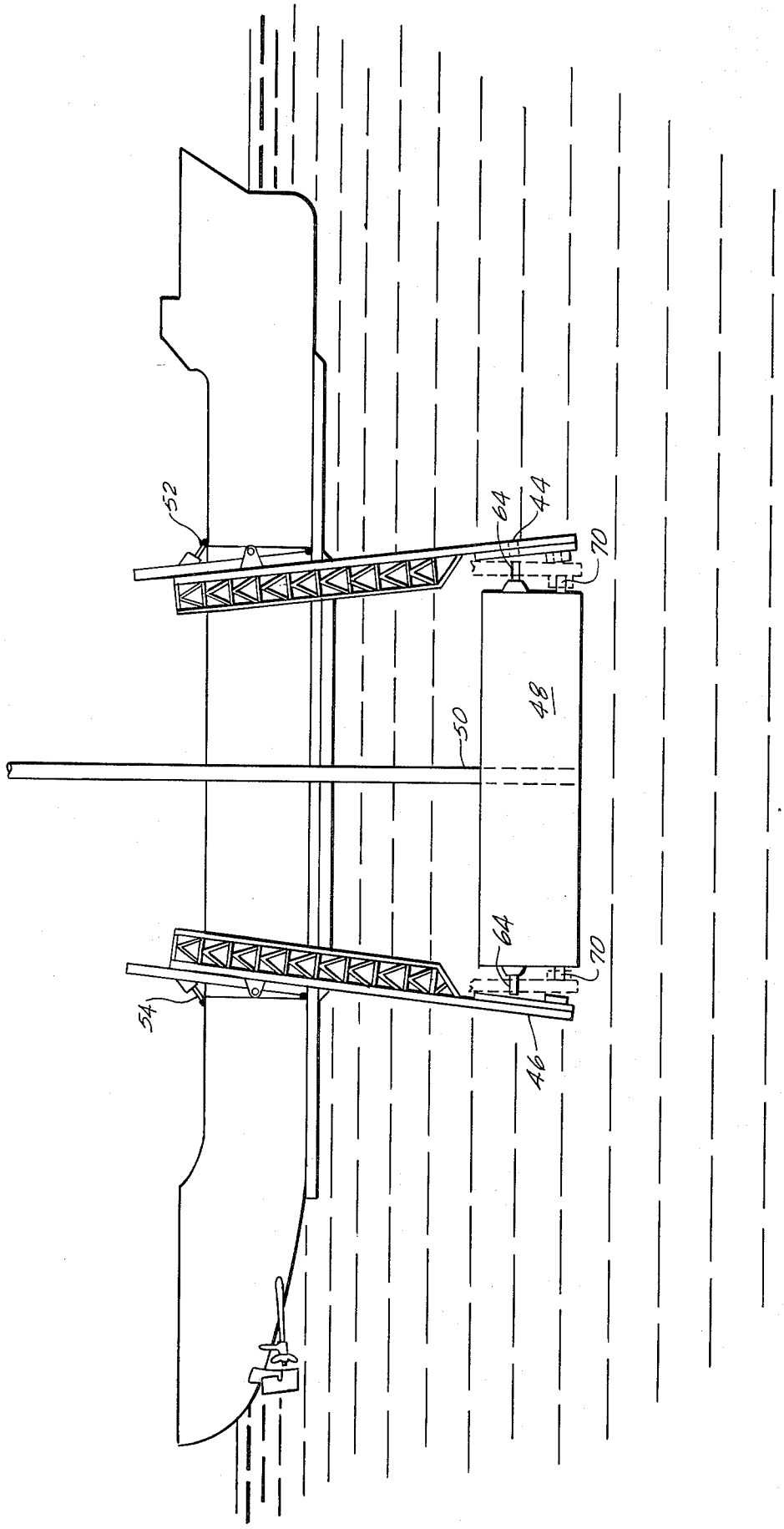


Fig. 3

Fig. 4

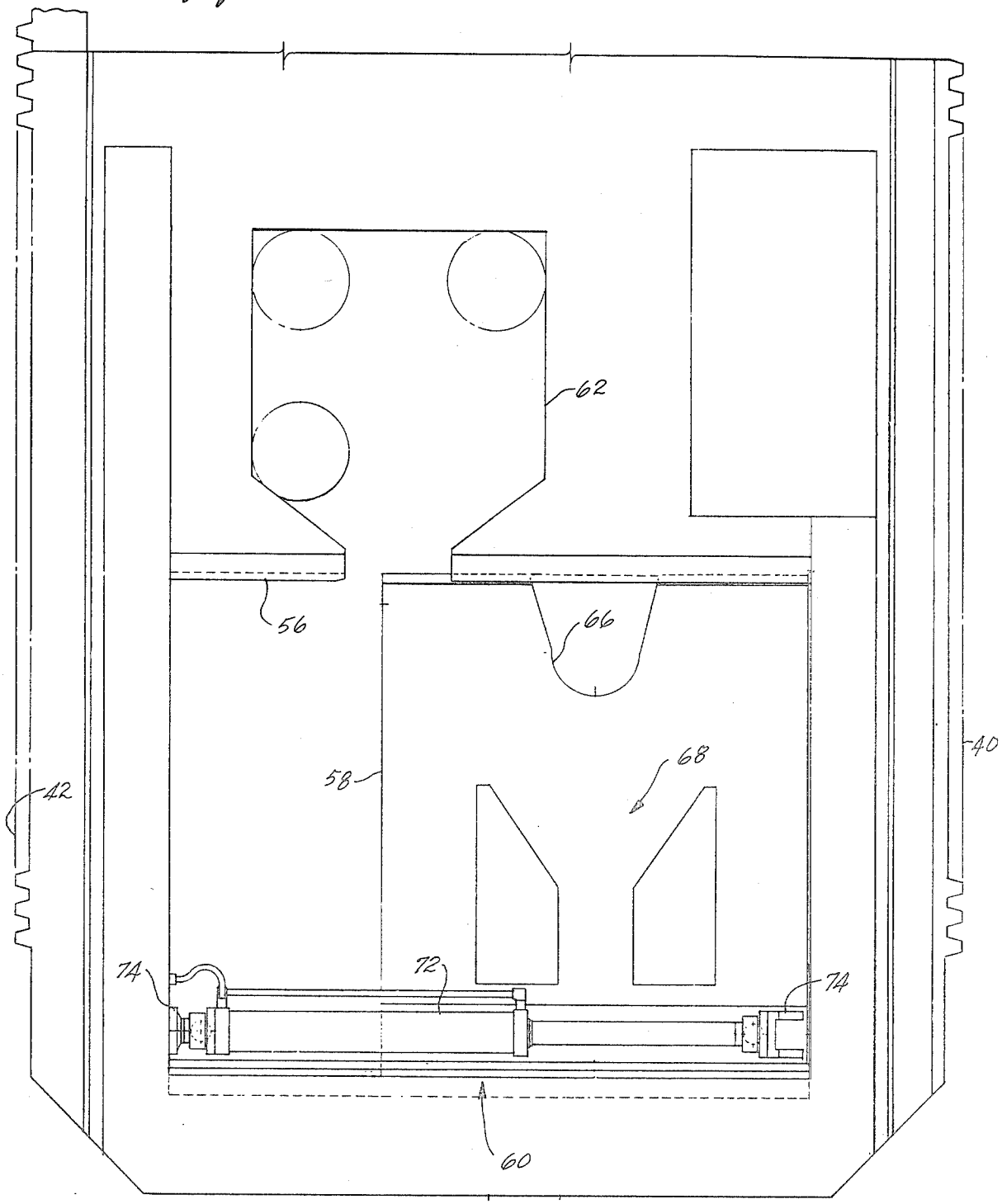
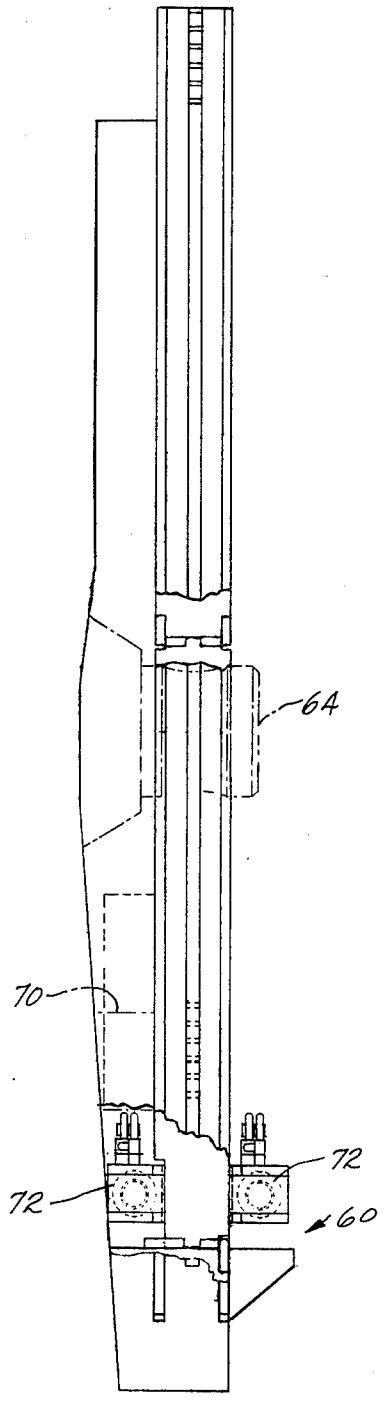


Fig. 5



APPARATUS FOR RAISING AND LOWERING LARGE OBJECTS FROM A SURFACE SHIP

FIELD OF THE INVENTION

This invention relates to a ship used for deep ocean mining and more particularly to a docking apparatus for engaging and disengaging a mining machine or vehicle from a floating surface vessel at the beginning and end of a mining sequence.

BACKGROUND OF THE INVENTION

In copending application Ser. No. 479,092 filed June 13, 1974, and titled "Deep Ocean Mining Ship" filed in the names of John R. Graham and Robert C. Crooke as inventors, and assigned to the same assignee as the present invention, there is described a deep ocean mining ship in which heavy mining equipment can be raised between the vessel and the ocean floor. The ship includes a large well in the center thereof which passes through and is enclosed by the hull. This well is closable across the bottom by movable gates. The vessel also includes a pipe handling system for moving mining pipe sections between a storage position and the drill string extending from the vessel to the mining machine to support the mining machine. A lift system operates to raise and lower the drill string with a continuous movement.

Finally, a docking apparatus is provided for use in raising and lowering the mining equipment to and from the stowed position within the vessel at the beginning and end of the mining sequence. As described herein, the docking apparatus includes two large extendable and tiltable legs, one at each end of the docking well. These legs are extended beneath the ship to lower and retrieve a mining vehicle and return it to the confines of the ship. Once the vehicle is within the well, the gates at the bottom of the vessel are closed and water is pumped out of the well to provide a self-contained drydock for maintenance of the mining machinery.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus for raising, lowering, and stowing subsurface mining equipment relative to a floating surface vessel comprising a pair of docking legs located at opposite sides of the well internal to the hull of the vessel and opening through the bottom thereof. Guide means are located at each of said sides of the well for supporting the docking legs. First drive means are operatively engaged with the guide means and the docking legs for raising and lowering the legs and second drive means are operatively engaged with the docking legs for tilting the legs in a vertical plane. Mining equipment engaging means are provided at the lower extremity of each docking leg.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing invention can be better understood by reference to the drawings, wherein

FIG. 1 is a perspective view of a ship incorporating the docking apparatus of the present invention;

FIG. 2 is a side elevation view of the vessel of FIG. 1;

FIG. 3 is a phantom view of the vessel of FIGS. 1 and 2 depicting the docking apparatus of the present invention in the extended position and tilted;

FIG. 4 is a front elevational view of the docking panel and slide mechanism located at the lower extremity of each of the docking legs, and

FIG. 5 is a side elevational view of the docking panel and slide mechanism of FIG. 4.

DETAILED DESCRIPTION

A vessel **10** equipped with two docking legs **12** is shown in FIG. 1 and FIG. 2. As shown therein, legs **12** are in a retracted position. When a mining machine or vehicle is on board, the legs in the retracted position hold and lock the vehicle in stowage in the docking well **18**. In operation, the legs raise and lower the mining vehicle from and to a position below the ship where it makes the transition from the docking legs to the lift system. Drive power is supplied by a rack and pinion mechanism located within a guide frame **14** on either side of each leg **12**. A port tilt mechanism **16** and a starboard tilt mechanism **17** are mounted on the main deck on either side of the forward and aft guide frame and are mechanically linked to the guide frame to provide a fore and aft tilting motion to each docking leg during release and capture of the vehicle at the beginning and end of a mining sequence. Also extending between the guide frame and the tilt mechanism foundation supports on the main deck are a port locking bar **23** and a starboard locking bar **24** which lock and hold the docking legs in the vertical position. Hydraulically operated locking pins associated with each bar engage the docking legs to accomplish the docking function.

As shown in FIGS. 1 and 2, the docking leg structure utilizes triangular trusses. The structure is a series of K-type trusses utilizing members circular in cross section with horizontal girts and cross bracing.

Each guide frame **14** comprises a pair of elevating or hoisting units **26, 28** located on opposite sides of each docking leg with the pair of units being connected together and braced by means of an open-type truss assembly **30**. The guide frame is mounted at the fore and aft ends of the docking well **18** by means of large pad eyes or brackets **31** and hinge pins **32** and **34**. The pad eyes are an integral part of the ship's fore and aft bulkheads **36, 38** in the well. As indicated above the guide frame **14** is also mounted and supported by means of tilting mechanisms **16, 17** to the guide frames **26, 28** at a point approximately 8 feet above the main deck and locking bars **23** and **24**.

The guide frame also contains a guide shoe at each side of the docking leg for controlling the vertical motion of the docking legs. Each elevating unit (**16** drive pinions per leg, eight per side) engages a rack of teeth **40, 42** (FIG. 4) provided at the outboard side of the docking legs. The elevating unit at each side of the guide frame contains a vertically mounted eight-pinion drive mechanism, all of which pinions engage the rack of each docking leg at the same time. Each pinion of each driver mechanism is independently driven by separate electrical motors and controlled by integrated controllers.

As indicated, a tilting drive mechanism is mechanically linked between the guide frame and the main deck for inclining the legs from the vertical toward or away from the center of the docking well to facilitate the capture and release of the mining vehicle by docking panels **44, 46** located at the lower extremity of each docking leg **12** as shown in FIG. 3. Capture and release of the subsurface mining vehicle **48** occurs while dock-

ing and undocking the vehicle and must be coordinated with transfer of the mining vehicle to and from a drill string **50.**

Each tilt mechanism consists of two double-acting hydraulic cylinders, **52, 54,** one connected to and acting upon each guide frame on either side of each of the two docking legs. The power source for the hydraulic cylinders consists of two independent tilt cylinders connected to a common hydraulic power unit. Driven by the hydraulic power unit, the tilt cylinders are caused to extend or retract, thus tilting the guide units in either a fore or aft direction and in the presently preferred embodiment are capable of tilting the docking legs through a maximum arc of travel of plus or minus 7°. Reservoirs which serve as accumulators allow the tilting system to act as a dampening mechanism which is used to reduce motion of the vehicle relative to the ship once the vehicle has been captured by the docking legs until the relative motion is reduced to zero.

At the lower extremity of each leg is a docking panel **44** shown in front and side elevation views in FIGS. **4** and **5.** Each docking panel includes an upper and a lower portion or section **56, 58** with the lower portion being linked to and capable of being laterally driven relative to the upper portion by a docking panel hydraulic system **60.**

Located in the upper portion is a generally square aperture **62** which receives a lifting pin **64** extending from each end of the mining vehicle. The docking panel in FIG. **4** illustrates the lower panel portion **58** in its laterally translated position with respect to the upper portion **56.** In its untranslated position a rounded slot **66** mates with the bottom of aperture **62.** Aligned with slot **66** in lower panel portion is a second keyhole-shaped slot **68** which engages locking pin **70** also located at each end of the mining vehicle below the lifting pin. When the docking leg is raised to a position such that the lift pins **64** are seated in rounded slot **66** and the locking pin **70** is seated, the mining machine is held in a stable position in all three axes of pitch, yaw, and roll. When the mining machine is captured by the legs, the lower slide panel **58** can be translated such that the pin resting in slot **66** is captured by the docking panel structure.

The slide cylinder **72** of the docking panel hydraulic system can be seen at the bottom of the lower docking panel section **58** in FIG. **4.** Each end of the slide cylinder is provided with a clevis **74** for connecting the slide cylinder apparatus to its mounting pins on the docking panel structure; one end is connected to fixed structure, the other end to the sliding panel.

The docking and undocking of the mining vehicle **48** proceeds in the following manner. The vehicle when stored in the docking well **18** is secured in position by the docking legs which are in turn locked in the vertical position by the hydraulically operated pins of the locking bar system **20.**

Before undocking the well is flooded and the gates **76** and **78** are opened. The mining vehicle is lowered below the ship's hull and the locking pins are then retracted. The elevating units of the docking leg system are operated with the pinions of the driver mechanisms engaging each rack **40,42** along the outboard side of the legs thus lowering the vehicle approximately 100 feet below the bottom of the ship. The docking panel hydraulic system shifts the two panel sections **56, 58** into the aligned position in two stages, at the halfway point of descent and at the completion of the descent. Prior to completion of the descent the drill string **50** is lowered through the docking well and attached to the mining vehicle.

The undocking operation is completed by raising the drill string a small amount to permit the lifting and locking pins **64, 70** to clear their respective receiving slots **66, 68.** Under drive by the tilting mechanisms **16, 17** the upper ends of the docking legs **12** are tilted inwardly clearing the vehicle **48** entirely of the docking panel structure. The vehicle is then lowered to sea bottom while the docking legs are returned to the vertical and retracted to the stowed position within the docking well.

The docking operation is the reverse of the foregoing. The docking legs are closed (returned to the vertical) after the drill string has positioned the vehicle such that lifting pins **64** register with aperture **62.** After locating each lift pin in aperture **62,** the docking legs are raised so that the lift pins and locking pins **64, 70** at the fore and aft ends of the vehicle are each lowered into their respective rounded and keyhole slots **66, 68.** Once so engaged relative motion between the vessel and vehicle in pitch and yaw and heave is eliminated. Because each docking leg is hinged and hydraulically controlled, relative surge motion between the two can be reduced or eliminated by controlling the pressure of the tilt mechanism accumulator. This motion is further reduced as the vehicle is slowly retracted into the docking well.

After capture by the docking legs, the drill string **50** is disconnected and retracted. The vehicle is then retracted within the docking well **18,** the gates **76, 78** closed and the docking well is pumped out as the docking legs are locked into position. The docking panel slide mechanism and hydraulic drive system is used during docking and thereafter for the purpose of shifting the mining vehicle as required for stowage and for trimming the vessel when the mining vehicle is loaded on board.

What is claimed is:

1. An apparatus for raising, lowering, and stowing subsurface mining equipment relative to a floating surface vessel comprising

a pair of docking legs, each one located at a respective one of opposed sides of a docking well said docking well being located internally of the hull of the vessel and opening through the bottom thereof;

guide means located at each of said sides of the well for supporting the legs;

first drive means operatively engaged with each guide means and its associated docking leg for raising and lowering the leg;

second drive means operatively engaged with each docking leg for tilting the leg in a vertical plane; and

mining equipment engaging means located at the lower extremity of each docking leg.

2. Apparatus according to claim **1** wherein each second drive means is positioned along the longitudinal axis of the vessel and operates so as to incline the legs in a plane passing through said axis for moving the mining equipment engaging means into contact with the mining equipment beneath the ship.

3. Apparatus according to claim **2** wherein each engaging means includes a docking panel at the lower extremity of each docking leg.

4. Apparatus according to claim 3 including locking means for securing each of the legs in a vertical position.

5. Apparatus according to claim 3 wherein each of the docking panels includes an aperture for receiving a pin extending from the mining vehicle when the vehicle is located in the docked position.

6. Apparatus according to claim 5 wherein each docking panel includes a slot disposed below the aperture for receiving a second pin from the vehicle in the docked position for prevention of roll motion of the vehicle relative to the vessel.

7. Apparatus according to claim 5 wherein each docking panel is comprised of an upper portion and a lower portion laterally translatable relative to the upper portion.

8. Apparatus according to claim 7 wherein said aperture in each docking panel is formed partially in said upper portion and partially in said lower portion and the slot is located on the lower docking panel portion.

9. Apparatus according to claim 7 including docking panel drive means for providing lateral translation of each docking panel lower portion and the mining vehicle relative to the associated upper portion.

10. Apparatus according to claim 1 wherein each of the guide means is hinge mounted in the docking well.

11. Apparatus according to claim 10 wherein each guide means includes a starboard and port guide unit supported and joined together by a structural brace, each of said guide units being hinge mounted within the docking well.

12. Apparatus according to claim 10 wherein each of the second drive means includes hydraulic drive means mounted on the main deck and mechanically linked to its associated guide means.

13. Apparatus according to claim 12 wherein each of the first drive means is housed within the guide units and comprises multiple motor driven pinion means for engaging a gear rack provided along the length of the outboard side of each docking leg structure.

14. Apparatus according to claim 13 wherein each guide unit includes a guide shoe coacting with the side of the associated docking leg.

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