SHIP STRUCTURE AND HANDLING MEANS FOR UNDERWATER MINING

Original Filed Dec. 24, 1963

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ATTORNEYS
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Fig. 10

Fig. 11

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13 Claims. (Cl. 114—5)

ABSTRACT OF THE DISCLOSURE

A ship carrying all of the necessary components for carrying out an underwater mining operation is provided with a central well formed therein opening upwardly and downwardly of the ship. The underwater mining equipment includes a pumping means and a movable dolly means for supporting the pumping means in a stowed position and for moving it into an operative position. The dolly means includes a body means formed as an open framework of rigidly interconnected frame members. Wheels are rotatably supported at opposite sides of the framework, and a pair of tracks extending longitudinally of the ship support the wheels for movement thereon and into operative position. A plurality of spaced anti-roll stops are fixed to the deck of the ship and are spaced laterally outwardly of the tracks, these anti-roll stops being adapted to engage portions of the body means of the dolly to prevent undesired movement of the dolly in an athwartships direction when the ship rolls. A central portion of the framework of the body means of the dolly is adapted to support the pumping means. Outwardly projecting towing pins are provided at opposite sides of the dolly at one end thereof, these pins being adapted to engage towing links to move the dolly along the tracks.

Support means is provided in the well of a ship for supporting portions of the underwater mining apparatus extending downwardly through the well. The well is defined by certain wall portions, and the support means includes a pair of moveable portions the lower ends of which are pivotally supported adjacent the wall portions of the well, the upper ends of the moveable portions of the support means each including a support portion. The wall portions of the well define recesses into which the moveable portions of the support means are adapted to be pivoted so as to provide a substantially unobstructed central well area through which the mining equipment can be lifted and lowered. Cables are connected to the upper ends of the moveable portions of the support means and are secured on cable drums which are adapted to be remotely operated by hand wheels whereby the moveable portions can be pivoted into and out of the central well area from a remote location.

The support portions at the upper ends of the moveable portions of the support means are provided with recessed or cutout areas which receive and support certain portions of the underwater mining equipment. These cutout portions are arcuate in configuration to receive a flange or collar on a conduit section.

Locking means in the form of a pair of arms is provided, these arms being pivotally supported on one of said support portions and being movable into engagement with lock pins on the other of the support portions, this locking means preventing the support portions from separating from one another when in operative position in the central part of the well.

A snubber means is supported within the well portion below the support means. The snubber means includes a pair of substantially semi-cylindrical portions which are secured to one another by nut and bolt assemblies. Each of these semi-cylindrical portions has outwardly extending spaced lugs thereon, a cable being connected between each of said lugs and a fixed wall portion of the well. Turnbuckles connected with the cables are adapted to take up any slack therein so as to hold the snubber means in fixed position at the central part of the well. Each of the four cables is disposed at substantially a 90-degree angle with respect to the adjacent cables.

The present application is a division of copending U.S. patent application Ser. No. 332,999, filed Dec. 24, 1963.

The present invention relates to new and novel ship structure and handling means for underwater mining, and moreover particularly to mining operations which are carried out at great depths beneath the surface of the sea.

The present invention is directed to the underwater mining of solid substances disposed at the bottom of the sea such as manganese nodules which are resting on the sea bottom and which are found in quantities sufficient for commercial mining at depths ranging generally from 400 feet to 12,000 feet or more beneath the surface of the sea.

The apparatus employed for mining such substances according to the present invention includes a novel ship structure adapted to move through the water over a particular mining area of the sea bottom, a collecting means being provided which moves along the sea bottom itself to collect the solid substances, and a conduit means is provided for directing a cable from the collecting solid bodies from the collecting means up to the ship.

The conduit means of the invention is preferably formed of a plurality of individual conduit sections which may be readily assembled and disassembled with respect to one another, and suitable means is provided for storing and handling these individual conduit sections.

The ship structure is also provided with means for stowing the collecting means and for moving it into and out of its operative relationship with respect to a central well portion provided in the ship through which the underwater mining equipment is lifted and lowered.

The present invention contemplates a completely self-contained ship which is adapted to carry out the underwater mining operations far out at sea, the ship being designed to operate for extended periods of time with all of the equipment required for the underwater mining operation being carried by the ship and stowed on board. In addition, the ship includes storage means for storing the collected nodules at sea.

The ship includes a particular arrangement for stowing the various components required in the underwater mining operation, and furthermore suitable handling means is provided on the ship for maneuvering the various pieces of equipment into and out of operative mining position.

The ship is provided with a novel well portion located at a central part of the ship such that when the ship is in operative mining position, the well portion opens downwardly into the sea and facilitates handling of the mining equipment which depends through this well portion from the ship downwardly to the sea bottom. The portion of the ship structure adjacent to the well comprises a reinforced hole arrangement which serves to rigidify and strengthen the ship structure adjacent to the well.

The central well portion permits ready access to the sea for lowering large heavy components of the underwater mining equipment into the sea and for lifting such equipment out of the sea, this well portion being so positioned as to facilitate handling of the equipment on the
ship and positioning of the ship properly for lowering operations. The ship is also provided with means which provides a stable ship for supporting the underwater mining equipment and which permits the ship to be precisely controlled and accurately maneuvered into proper position. Since the mining operation or movement of the collecting means will nominally be at speeds less than 5 knots, a controllable reversible pitch propeller is provided for obtaining the necessary control. In order to assure a reasonably steady ship's heading, a bow thruster means is installed in the bow portion of the ship to counter the effects of wind and sea. In a typical example, the ship should be designed for a free route speed of about 14 knots for travel between port and the mine site with cargo and wing tanks ballasted as required to maintain a draft of about 30 feet with the underwater mining equipment stowed as illustrated in the drawings. Anti-roll tank means is also incorporated in the ship to minimize roll and to provide the maximum degree of stability.

Since all of the underwater mining equipment is adapted to be carried to the mining site by the ship, the ship must include means for stowing all of the equipment on board and for handling the equipment to move it from its stowed position into operative mining position and to return it to its stowed position when required.

The underwater mining equipment when supported in operative mining position is suspended downward through the well portion formed in the ship, and since the collecting means is travelling along the bottom of the sea while the ship is moving to a certain degree on the surface of the sea with respect to the underwater components, it is necessary to permit a certain degree of relative movement between the conduit means and the ship. Accordingly, means is provided for supporting the conduit means from the ship so that such relative movement may occur.

The mining ship of the present invention is adapted to store a substantial quantity of solid bodies of collected material within hold means provided therein, and the hold means of the present invention is of particular construction so as to receive such solid bodies of material. In addition, since the storage means on the ship is limited, it is essential in order to provide an economical operation to be able to transfer the solid bodies from the holds of the mining ship to the auxiliary cargo ship while the mining ship is at sea and conducting substantially continuous mining operations. Accordingly, the present invention also provides a unique transfer system which permits the cargo stored within the holds of the mining ship to be transferred to another ship on the high seas. A principle involved here is to tow a cargo ship about 600 feet astern of the mining ship and to float a suitable conduit means between the two vessels. The cargo is fluidized and pumped to the cargo ship by means of the novel transfer system incorporated in the mining ship itself.

The mining ship also includes a stowage means for stowing the individual sections of the conduit means closely adjacent to the well portion so that the conduit sections may be readily moved into operative relation for lowering into mining position, and further whereby the sections may be returned to the stowage base when disassembling the conduit means.

Suitable handling means is provided on the ship to enable the handling of the underwater mining components. An overhead bridge crane means arranged for bridge travel in a fore and aft direction and trolley travel athwartships is provided for lifting and lowering the components as required.

In addition, a movable support means is mounted for movement in a fore and aft direction along the deck of the ship, this support means including its own driving means and power operated clamping means which is adapted to engage and support certain of the underwater mining components. Means is also provided for locking the movable support means against movement relative to the deck and further for locking the clamping means in operative position when underwater.

A further movable support means is provided for particularly supporting the pumping means on the deck of the ship, this last-mentioned support means also being movable fore and aft along the deck. Elevator means is also provided which is movable into the well portion and therefrom for maneuvering various components of the underwater mining apparatus into the desired position. This elevator means also includes clamping means for clamping and holding portions of the underwater mining equipment. Means is provided for locking this elevator means in several different operative positions as the case may be, and gimbal means is provided for permitting the necessary degree of relative movement between the conduit means and the ship during the mining operation, this gimbal means being operatively supported in a central part of the elevator means.

In addition to the elevators which is adapted to clamp and hold certain components within the well portion, an auxiliary support means is also provided which is selectively movable into operative position within the well portion for supporting certain components therewithin.

An object of the invention is the provision of apparatus for underwater mining which is particularly adapted for mining operations at great depths beneath the surface of the sea under varying environmental factors such as prevailing winds, sea currents and sea conditions.

A further object of the present invention is to provide a mining ship including means which permits ready access to the sea for lowering large heavy components of the mining equipment into the sea and for lifting such equipment out of the sea, and which is so positioned as to facilitate handling of the equipment on the ship and positioning of the equipment properly for lowering operations.

Another object is to provide a ship for use in underwater mining operations including means which provides a stable ship for supporting the underwater mining equipment, the ship being capable of being precisely controlled and accurately maneuvered into any desired position for carrying out underwater mining operations.

A further object of the invention is to provide a unique ship for use in underwater mining operations which is a self-contained unit and which includes means for storing all the equipment on the ship and for handling the equipment as required to move it into or out of operative mining position.

A further object of the invention is to provide a ship for use in underwater mining operations including means for supporting conduit means utilized in the underwater mining operation in operative mining position and permitting a certain degree of necessary relative movement between the conduit means and the ship.

Another object of the invention is the provision of a ship for use in underwater mining operations including novel cargo storage means and incorporating a unique transfer system for transferring the cargo from the storage means to a cargo ship while the mining ship is conducting underwater mining operations.

A further object of the present invention is to provide a ship for use in underwater mining operations including stowage means for stowing individual conduit sections in as compact a space as possible.

A still further object of the present invention is to provide a movable support means which is adapted to support components of the underwater mining equipment and to move relative to the supporting deck surface for transferring components from one position to another.

Another object is the provision of a movable support means which comprises a self-contained unit including
its own driving means and power operated clamping means.

A further object of the invention is to provide a movable support means adapted to move relative to a supporting deck surface and including means for holding the movable platform means in fixed position relative to said deck means and also to provide means for holding the movable clamping means of the support means in its operative clamping relationship when the clamping means is under load.

Another object of the invention is to provide novel dolly means which is adapted to move along the deck of the ship and to support components of underwater mining equipment and which further is adapted to be coupled to a movable means for moving the dolly means into a desired operative position.

A further object of the present invention is to provide underwater mining equipment including a ship having a well portion therein opening downwardly into the sea and including auxiliary support means having separate support portions which are movable into supporting position to support underwater mining equipment components at the central part of the well, these movable support portions also being movable out of the well portion to provide a substantially unobstructed well area through the ship.

Another object of the invention is the provision of auxiliary support means as defined in the previous object and including an additional means therefor for engaging and holding certain portions of underwater mining equipment in fixed spaced relation to the walls of the well portion.

A further object of the present invention is to provide apparatus for underwater mining at great depths beneath the surface of the sea including a ship having a well portion therein opening both in an upward and in a downward direction and elevator means associated with said well portion and movable so as to lower components of underwater mining equipment into said well portion and to lift such components out of said well when desired.

Another object is to provide elevator means as aforesaid including means for selectively clamping and holding underwater mining equipment components in position while the elevator means itself is lifted or lowered as the case may be.

A further object of the invention is to provide elevator means as described above which includes gimbal means for supporting mining equipment in operative position and which permits the necessary relative movement between the underwater mining equipment and the ship.

Still another object of the invention is the provision of elevator means movable in an up and down direction as aforesaid and providing lock and stop means for locking the elevator means in particular operative positions and to limit movement of said elevator means in a downward direction.

Other objects and many attendant advantages of the invention will become more apparent when considered in connection with the specification and accompanying drawings wherein:

FIG. 1 is a side elevation of the rear or stern half of a mining ship according to the present invention;

FIG. 1' is a side elevation of the front or bow half of the ship shown in FIG. 1, it being understood that FIG. 1' is to be matched with FIG. 4 so as to provide an illustration of the over-all ship;

FIG. 2 is a top view of that portion of the ship shown in FIG. 1, with certain portions removed for the sake of clarity of illustration;

FIG. 2' is a top view of that portion of the ship shown in FIG. 1, it being understood that FIG. 2' is to be matched with FIG. 2 so as to provide a top view of the over-all ship, with certain portions removed for the sake of clarity of illustration;

FIG. 3 is a view illustrating the manner in which collected solid bodies of material are transferred from the mining ship to another ship;

FIG. 4 is a sectional view taken substantially along line 4—4 of combined FIGS. 1—1' looking downwardly in the direction of the arrows;

FIG. 5 is a sectional view taken substantially along line 5—5 of combined FIGS. 1—1' looking downwardly in the direction of the arrows;

FIG. 6 is a sectional view taken substantially along line 6—6 of FIG. 4 looking in the direction of the arrows;

FIG. 7 is a sectional view taken substantially along line 7—7 of FIG. 1' looking in the direction of the arrows;

FIG. 8 is an enlarged side elevation of a portion of the ship with certain parts removed or broken away for the sake of clarity.

FIG. 9 is a view taken substantially along line 9—9 of FIG. 8 looking downwardly in the direction of the arrows;

FIG. 10 is a sectional view taken substantially along line 10—10 of FIG. 8 looking in the direction of the arrows;

FIG. 11 is a sectional view taken substantially along line 11—11 of FIG. 8 looking downwardly in the direction of the arrows;

FIG. 12 is a top perspective view partially broken away and with certain parts removed for the sake of clarity illustrating a portion of the stowing area, two different operative positions of the overhead crane mechanism and showing the movable support means in operative position overlying the well portion of the ship;

FIG. 13 is a top view of the movable support means according to the present invention;

FIG. 14 is an elevation of the movable support means illustrated in FIG. 13;

FIG. 15 is a sectional view taken substantially along line 15—15 of FIG. 14 looking in the direction of the arrows;

FIG. 16 is a sectional view taken substantially along line 16—16 of FIG. 14 looking in the direction of the arrows;

FIG. 17 is a sectional view taken substantially along line 17—17 of FIG. 13 looking in the direction of the arrows;

FIG. 18 is a top view of the dolly means of the present invention which is particularly adapted for supporting the pumping means;

FIG. 19 is a sectional view taken substantially along line 19—19 of FIG. 18 looking in the direction of the arrows;

FIG. 20 is a sectional view taken substantially along line 20—20 of FIG. 18 looking in the direction of the arrows;

FIG. 21 is a top perspective view partially broken away and with parts removed for the sake of clarity illustrating the manner in which the auxiliary support means of the present invention is mounted with respect to the well portion of the ship;

FIG. 22 is a sectional view taken substantially along line 22—22 of FIG. 21 looking in the direction of the arrows;

FIG. 23 is a sectional view taken substantially along line 23—23 of FIG. 22 looking in the direction of the arrows;

FIG. 24 is a sectional view taken substantially along line 24—24 of FIG. 22 looking in the direction of the arrows;

FIG. 25 is a top perspective view partly broken away and with certain parts removed for the sake of clarity which illustrates the general arrangement and interrelationshp of the well portion of the ship, the elevator means, and the means for lifting and lowering the elevator means;
FIG. 26 is a sectional view taken substantially along line 26—26 of FIG. 25 looking in the direction of the arrows;

FIG. 27 is a sectional view taken substantially along line 27—27 of FIG. 26 looking in the direction of the arrows;

FIG. 28 is a view looking downwardly in the direction of the arrows along the line 28—28 of FIG. 27;

FIG. 29 is a sectional view taken substantially along line 29—29 of FIG. 26 looking in the direction of the arrows;

FIG. 30 is a sectional view taken substantially along line 30—30 of FIG. 27 looking in the direction of the arrows;

FIG. 31 is a top view partly broken away of the elevator means itself;

FIG. 32 is a sectional view taken substantially along line 32—32 of FIG. 31 looking in the direction of the arrows;

FIG. 33 is a sectional view taken substantially along line 33—33 of FIG. 32 looking in the direction of the arrows;

FIG. 34 is a sectional view taken substantially along line 34—34 of FIG. 33 looking in the direction of the arrows;

FIG. 35 is a top perspective view illustrating the construction of the gimbal means of the present invention;

FIG. 36 is a top view of the gimbal construction shown in FIG. 35; and

FIG. 37 is a sectional view taken substantially along line 37—37 of FIG. 36 looking in the direction of the arrows.

Referring now particularly to FIGS. 1—1' and 2—2', the mining ship according to the present invention is illustrated, it being understood that FIGS. 1 and 1' and FIGS. 2 and 2' must be considered in connection with one another. As seen in these figures, the over-all ship 110 is provided with a controllable reversible pitch propeller 114 at the stern portion thereof, and a steering rudder 115 is provided for steering the ship. A well portion 125 is provided at a central portion of the ship and is disposed substantially symmetrically about the longitudinal center line of the ship. This well portion receives the upper end portion 126 of the conduit means which extends downwardly to a collecting means which moves along the sea bottom. The elevator mechanism for lifting and lowering various components of the underwater mining apparatus is indicated by reference numeral 128. This elevator mechanism is adapted to be lowered down into the well portion and to be raised therefrom as will be hereinafter more fully described.

The four main cargo holds are indicated generally by reference numerals 135, 136, 137 and 138, the separator mechanism 150 being mounted on the upper deck for receiving the mixture discharge from the upper end portion 129 of the conduit means which is of flexible construction. The conveyor mechanism indicated generally by reference numeral 132 includes a longitudinally extending portion 132' as most clearly seen in FIG. 2—2', this longitudinally extending portion comprising a conventional belt conveyor which may be driven in the usual manner by a driving motor indicated at 343, this endless belt conveyor receiving solid bodies of material discharged from the separator means and carrying these solid bodies of material longitudinally on the ship.

A first plurality of spaced similar hatches 345 shown as being in number and spaced longitudinally from one another are adapted to receive solid bodies of material to be stored in hold 135. It will be noted that the aft hatch of these three hatches is disposed aft of the separator mechanism 150, and a separate conveyor portion 346 may be provided for feeding solid bodies of material to this particular hatch. A second plurality of spaced similar hatches 348 shown as being three in number are adapted to receive solid bodies of material for storage in hold 136. A third plurality of hatches 349 are adapted to receive solid bodies of material from the conveyor portion 132' for storage in hold 137. A fourth plurality of hatches 350 are adapted to receive solid bodies of material from conveyor portion 132' for storage within hold 138. Suitable gate mechanisms of conventional construction may be provided for diverting the solid bodies of material from the conveyor portion 132' into the various hatches in a well known manner. It is apparent that any suitable type of conveyor mechanism may be employed for transferring the collected solid bodies of material from the separating mechanism 150 to the various hatches associated with the individual holds. The details of construction of the various holds will be set forth in detail hereinafter.

As seen particularly in FIG. 1', a helicopter indicated generally by reference numeral 352 is supported in spaced relationship above the deck and the conveyor mechanism, this helicopter serving to provide a landing platform for a helicopter which may be utilized for travelling to and from the mining ship.

Also as seen in FIG. 1', the bow thruster mechanism is indicated by reference numeral 113 and the details of construction of this bow thruster mechanism will be described hereinafter.

Referring now particularly to FIGS. 1 and 2 a conventional boarding ladder is indicated by reference numeral 354. A pair of booms 356 and 357 are mounted at the starboard and port sides respectively of the ship, and in a typical example, boom 356 may comprise a five-ton boom and boom 357 may comprise a 20-ton boom.

A supporting superstructure is indicated generally by reference numeral 360, this superstructure comprising a plurality of interconnected beam members which provides sufficient strength for supporting the overhead crane mechanism and the bridge structures hereinafter described, this superstructure comprising a framework supported at the outboard portions of opposite sides of the ship and including transverse portions at the upper part thereof for supporting the mechanism referred to. The navigating bridge supported by the superstructure is indicated generally by reference numeral 361, and the underwater mining control station is indicated generally by reference numeral 362 from which the overall operation of the underwater mining procedure can be coordinated.

An overhead travelling crane is indicated generally by reference numeral 365, and as seen particularly in FIG. 10, the overhead crane mechanism includes a transversely extending body portion 365 having wheels or rollers 366 mounted at the opposite sides thereof and which are supported upon rails 368. These rails extend substantially parallel with the center line of the ship and longitudinally thereof, and are supported by portions 370 of the superstructure. The wheels 366 of the crane mechanism preferably have positive engagement with the track portions 368 to prevent fore and aft runaway of the crane mechanism.

A trolley means 372 as seen most clearly in FIG. 36 is mounted for movement athwartship by means of wheels 373 mounted upon suitable transversely extending track portions 374. The trolley wheels also preferably have positive engagement with the associated tracks to prevent athwartship runaway. Suitably powered means is provided for driving the main crane body portion 365 and the trolley 372 so as to properly operatively position a depending hook mechanism indicated by reference numeral 375. A winch or other suitable lifting and lowering means is indicated by reference numeral 376 and is operatively connected to the hooks 375 and supported by the trolley means whereby the hook means may be operatively positioned in any desired..
location. The crane cab within which an operator is supported is indicated by reference numeral 378.

Referring again to FIG. 1, suitable ladder means 380 is provided for enabling personnel to climb from the upper deck to the navigating bridge and the control station. A portable rail means 382 is provided around the outer portion of the ship. The living quarters of the officers and crewmen are indicated generally by reference numeral 383, and the conventional funnel is indicated by reference character F. As seen in FIGS. 2-2', a work boat 385 is supported on the deck, and a diving gear locker 386 is disposed forwardly of the work boat.

Referring now particularly to FIGS. 8, 9, 10 and 11, certain details of the construction of the ship adjacent to the well portion and the general arrangement of the mining components stored on the deck may be more fully understood. As seen in FIG. 8, the elevator machinery space is located immediately aft of the well portion 125, and a spare motor and pump indicated by reference numerals 1240 and 1245 respectively are supported on a deck above the machinery space. The pipe stowage space indicated generally by reference numeral 142 is disposed aft of the elevator machinery space. Referring now to FIG. 11, a top view of the ship construction at the bottom shell is indicated. As seen in this figure, the well portion 125 is of rectangular configuration and in a typical example a dimension along the center line of the ship as indicated by line x-x of approximately 34 feet, while the dimension perpendicular to the center line may be approximately 30 feet. The corner portions of the well are preferably of arcuate configuration as indicated by reference numerals 190 and 391 and in a typical example may have a three foot radius, these curved corner portions serving to relieve the stress concentrations at these points.

In order to provide sufficient strength and rigidity to this portion of the ship, an extra heavy bottom plate indicated by reference numeral 393 is provided, this bottom plate in a typical example being a 66.1-lb. plate. A pair of insert plates 394 and 395 which also may be 66.1-lb. plates are provided adjacent the two corner portions of the well as indicated in FIG. 11, these plates including arcuate edge portions adapted to conform to the configuration of the arcuate corners of the well portion.

A bilge plate 397 is provided adjacent the bottom plate 393, a riveted joint 398 being provided between these two plates, the bilge plate may also be of heavy-duty construction and may for example be a 56.1-lb. plate. A pair of insert plates 405 and 406 are provided, these plates being of a similar weight to plate 403 and being provided at the corner portions of the well portion and having arcuate edge portions adapted to conform to the arcuate corners of the well portion, these arcuate corners being indicated by reference numerals 408 and 409. The adjacent plates as indicated by reference numerals 410 and 411 may be of usual deck composition and in a typical example may comprise 38.25-lb. plates.

It is apparent from the foregoing that the ship is provided with a reinforced bottom shell and upper deck adjacent to the lateral portions and corners of the well portion so as to reinforce these portions and to provide adequate rigidity and strength to the ship adjacent the well portion which extends completely through the ship in a vertical direction from the bottom shell to the upper deck.

A plurality of vertically upstanding members 413, 414, 415, 416 and 417 are provided at one side of the well portion and a corresponding plurality of upstanding vertical members 413', 414', 415', 416' and 417' similar to the first mentioned support members are provided at the opposite side of the well portion. It will be understood that these vertically upstanding members are portions of the superstructure which supports the overhead crane structure previously described. A pair of support members 420 and 421 extend upwardly from the outer lateral portions of the ship and slope inwardly to join with the superstructure at a point spaced a considerable distance above the deck to provide lateral stability for the superstructure.

The generally rectangular outline of the well portion 125 is indicated in dotted lines in FIG. 9, but the well portion is not of this configuration completely from the bottom shell to the upper deck, but is only of such generally rectangular configuration from the bottom shell to an intermediate portion of the well portion whereat certain inwardly extending bulkheads are provided as hereinafter described. The upper deck area is provided with recessed portions so as to provide clearance for the elevator structure and in a typical example a recessed portion may be provided as described, and as seen in FIG. 9 the upper deck is provided with a main generally rectangular recessed portion from which extend a first pair of rectangular recessed portions 423 and 424 at the aft portion of the main recessed portion, a second pair of rectangular recessed portions 426 and 427 extending laterally from an intermediate portion of the main recessed portion, and a third pair of rectangular recessed portions 429 and 430 extending outwardly from opposite sides of the forward portion of the main recessed portion. A recessed portion 432 extends forwardly of the well portion and is of generally rectangular configuration, and a recessed portion 433 of substantially V-shaped configuration extends aft of the well portion and will be more fully described hereinafter.

The elevator means is indicated generally by reference numeral 435 and has laterally extending portions thereof which fit within the recessed portions 423, 424, 426, 427, 429 and 430 previously described, the structure of the elevator mechanism being more fully set forth hereinafter.

Elevator sheave trunk portions 437 and 438 extend vertically upwardly from plate 408 and a similar plate 405' for receiving and protecting the sheaves and cables employed for lifting and lowering the elevator mechanism as hereinafter set forth. Holes 440 and 441 are provided in plates 405 and 405' respectively for allowing movement of the operating mechanism for the elevator mechanism therethrough.

Various components of the underwater mining equipment are illustrated in their normal stowed position on the upper deck of the ship as seen in FIG. 9, a collecting means 167 being supported on the deck in the position illustrated. The collecting means in this stowed position is disposed in overlying relationship to a first recessed hatch 443 which provides access to the stowage area for the individual sections of the conduit means. This collecting means is also in overlying relationship to an unshipping opening 444 to the elevator machinery room as hereinafter described.

It will be understood that the collecting means 167 as seen in FIG. 9 is disposed flat upon the deck, and an additional or reserve collecting means of substantially identical configuration is indicated at 167', this collecting means being stowed on end or at a substantially right angle position to that of collecting means 167, the reserve collecting means 167' being supported by a suitable support frame 446 which is preferably mounted for pivotal movement about an axis 448 with respect to the deck. With this arrangement, the support frame 446 can be
pivoted up into the stowed position as shown, or can be pivoted downwardly so as to place the reserve collecting means 167 in position for lowering it into operative mining position if so required. In addition to a further collect- means (not shown) may be stowed at the opposite side of the collecting means 167 as shown in a manner similar to the reserve collecting means 167.

As illustrated in FIG. 9, it is assumed that the truss construction adapted to be connected at the lower end of the conduit means to the collecting means is such that the overall truss means is formed of a plurality of individual truss sections which can be readily interconnected and disconnected as required. In FIG. 9, the first truss section is indicated generally by reference numeral 450, this truss section being pivotally interconnected as indicated at 451 with the collecting means 167. With this arrangement, the first truss section which is connected with the collecting means may remain pivotally interconnected therewith at all times, and the remaining truss sections are stowed in vertically extending positions, these remaining truss sections being indicated by reference numerals 453, the various sections being interconnected with one another and lowered into operative position. It is apparent that the truss sections occupy as little deck space as possible when stowed in such vertically extending position, and a portion of one of the truss sections may extend over the recessed portion 422 as illustrated. Porta-guard rails 454 and 455 are provided adjacent the well portion and the recessed portion 432 in the main deck to prevent personnel from accidentally falling into these recessed portions.

A pair of longitudinally extending tracks are provided for supporting certain movable equipment hereinafter described, the port track means including sections 458, 458', 458" and the second rail means including sections 460, 460', 460" and 460"'. It will be noted that the two track means are substantially parallel with one another and that the various sections thereof are interrupted by the recessed portion 432 formed in the main deck, however, the spacing between the various track sections as occasioned by these recessed portions is such that the movable equipment which is provided with wheels is continuously supported and guided by the tracks, or in other words some of the wheels are maintained in contact with the track sections in order to maintain the proper degree of support and guidance.

A first movable support means or platform dolly 462 is provided, this platform dolly being provided with wheels as hereinafter described which are movable along the tracks on the deck so that the platform dolly can move longitudinally back and forth as hereinafter described. The platform dolly is illustrated as supporting in stowed position thereon a dead weight means 153 which is adapted to be connected with the conduit means and to be pivotally interconnected with the truss means which in turn is pivotally connected with the collecting means.

A second movable support means or capsule dolly is indicated generally by reference numeral 464, this dolly being provided with wheels as hereinafter discussed and being movable along the tracks on the deck. This capsule dolly is illustrated as supporting thereon in stowed position the pump capsule 152.

A third support means is indicated generally by reference numeral 467, this support means being movable athwartships and serving to support in the stowed position a buoyancy capsule indicated generally by reference numeral 467. This buoyancy capsule is simply a large water-tight container which is adapted to be attached to the conduit means to provide buoyancy thereto as will be more fully discussed hereinafter.

As seen in FIG. 8, the dead weight means 153 includes a small conduit portion 470 extending upwardly therefrom including an intermediate collar portion 471 for facilitating handling of the dead weight means. An upper flange portion 472 is provided at the top of the conduit portion 470 and includes suitable holes formed therein for bolting this flange to a cooperating flange of a conduit section.

Referring now particularly to FIGS. 1 through 7 inclusive, the bow thruster mechanism details may be seen most clearly in FIG. 5 wherein it will be seen that a passage 475 extends laterally from one side of the ship to the other, and opens at opposite sides of the ship. A control pitch propeller 476 is supported within the central portion of the passage and is operatively connected with suitable driving mechanism indicated at 477. By controlling the pitch and therefore the direction and amount of thrust of the propeller 476, the heading of the bow of a ship can be very accurately controlled so as to enable proper maneuvering of the ship during mining operations.

As seen especially in FIG. 4, stabilizing means in the form of anti-roll tanks means includes a pair of anti-roll tanks 430 and 431 disposed at opposite sides of the ship. A pair of passages 432 and 433 extend athwartships and serve to interconnect the two anti-roll tanks. Liquid is disposed in the anti-roll tanks and in the connecting passages, the tanks and passages being less than full such that the liquid is adapted to move back and forth between the tanks through the passages. Suitable control means is provided for controlling the movement of liquid through the passages and this control means is indicated as selectively controllable gate means indicated by reference numerals 486 and 487 whereby the amount of liquid flowing through the connecting passages may be selectively adjusted. This over-all arrangement provides a very effective means for stabilizing the ship and for maintaining the ship in the proper attitude for effective mining operations.

Referring particularly to FIG. 4, hold 135 is divided into six individual hopper portions, the three hopper portions at the port side of the ship being indicated by reference numeral 490, and the three hopper portions at the starboard side of the ship being indicated by reference numeral 491. A central ridge portion 492 serves to separate the three port hopper portions from the three starboard hopper portions. Each of the port hopper portions 490 comprises a four-sided hopper, the sides being each being of a smooth construction such as metallic sheets, the four sides tapering downwardly from a portion spaced above the lower part of the hold to a discharge opening 494. As seen in FIG. 6, as well as in FIGS. 1-1', the major portion of the hold is unobstructed, the hopper portions being provided only in the lower minor portion of the hold so as to direct the collected solid bodies of material in the hold to the discharge openings for a purpose hereinafter described.

The three starboard hopper portions 491 each include three sloping side portions as seen in FIG. 4, the fourth side portion being substantially vertical along one side of the ridge portion 492. The three sloping side portions of each of the starboard hoppers 491 slope downwardly to a discharge opening 496.

Hold 136 also includes three port hopper portions 498 and three starboard hopper portions 500, the port hopper portions 498 including three sloping side portions such that these hopper portions are similar in construction to the hopper portions 491 previously described. The three starboard hopper portions 500 of hold 136 include four sloping side portions and are accordingly of similar construction to the hopper portions 490 previously described. The sloping sides of the port hopper portions 498 terminate at discharge openings 502, while the sloping side portions of the starboard hopper portions 500 terminate in discharge openings 503.

Hold 137 includes three port hopper portions 505 including four sloping sides similar to those previously discussed, these sloping sides terminating in discharge openings 506. Hold 137 also includes three starboard hopper
portions 507 including three sloping side portions similar in construction to those previously discussed, these sloping side portions being in discharge openings 508.

The hopper 138 includes three port hopper portions 510 having three sloping sides which terminate in discharge openings 506. Hold 138 also includes three starboard hopper portions 513 having four sloping sides which terminate in discharge openings 508.

Referring now particularly to FIG. 7, the hopper portions 505 and 507 of hold 137 are illustrated, and it will be noted that the discharge opening 506 of hopper portion 505 is in communication with a transversely extending conduit portion 517 which opens into a longitudinally extending conduit portion 518. A screw conveyor means 520 is mounted within the transversely extending conduit portion 518 and is connected through a speed reducing means 521 with a suitable driving motor 522. The screw conveyor means serves to provide a means for positively moving collected modules and the like from the discharge opening 506 of hopper portion 505 into the longitudinally extending conduit portion.

The discharge opening 505 of the hopper portion 507 opens into a transversely extending conduit portion 525 which also opens into the longitudinally extending conduit portion 518. A screw conveyor means 526 is disposed in the transversely extending conduit portion 525, and is connected through a speed reducing mechanism 527 with a driving motor 528. This last-mentioned screw conveyor means serves to positively displace collected modules from the discharge opening of the hopper portion 507 into the longitudinally extending conduit portion 518.

The interrelationship of the screw conveyor drive means with respect to the longitudinally extending conduit portion 518 may be seen in FIG. 5, and it will be noted that similar screw conveyor feed means indicated generally by reference numerals 520' are provided for the discharge openings 506 of the remaining hopper portions 505. Similar screw conveyor feed means 526' are provided in association with the discharge openings 508 of the remaining hopper portions 507. The various screw conveyor means in each instance will be substantially identical in construction with that described in connection with FIG. 7.

As seen in FIGS. 5, 6 and 1', in particular, the longitudinally extending conduit portion 518 includes an open end portion 530 which opens downwardly into the sea, a valve 531 being provided for controlling the flow of sea water into the conduit portion. The aft end of the conduit portion 518 opens into a large pump room 534 as seen particularly in FIGS. 5, 6 and 1'. A valve 535 is provided for controlling the flow of the sea water and a solid body mixture into the pump means.

Referring particularly to FIG. 5, three screw conveyor mechanisms indicated generally by reference numerals 538 are provided in association with the discharge openings of the port hopper portions 498 of hold 136, these screw conveyor mechanisms serving to positively displace solid bodies of collected material from these latter mentioned hopper portions into a longitudinally extending conduit portion 540.

Three screw conveyor mechanisms 542 are operatively associated with the three starboard hopper portions 500 of hold 136 and serve to positively displace solid bodies of material from the discharge openings into the longitudinally extending conduit portion 540.

Again referring particularly to FIGS. 5, 6 and 1', it will be noted that the longitudinally extending conduit portion 540 includes a downwardly facing inlet portion 544 open to the sea, a valve means 545 being provided for controlling the flow of sea water into the conduit portion. This last-mentioned conduit portion also is operatively connected with the pump means 535 previously described, a valve means 546 being provided for controlling the flow of sea water and solid body mixture into the pump means.

Referring again particularly to FIG. 5, three screw conveyor mechanisms 550 are operatively associated with the discharge openings of the hopper portions 510 of hold 138, these screw conveyor mechanisms being adapted to positively displace solid bodies of material from the hopper portions into longitudinally extending conduit portion 552.

Three similar screw conveyor mechanisms 554 are operatively associated with the discharge openings of the starboard hopper portions 513 of hold 138 and are adapted to positively displace the solid bodies of material from hopper portions 513 into the longitudinally extending conduit portion 552.

Again referring particularly to FIGS. 5, 6 and 1', longitudinally extending conduit portion 552 is provided with a downwardly opening portion 556 which opens into the sea, a valve means 557 being provided for controlling the flow of sea water into this conduit portion. This latter-mentioned conduit portion is also in communication with the pump 533, a valve 558 being provided for controlling the flow of the sea water and solid body mixture into the pump.

A fourth longitudinally extending conduit portion 560 is provided for receiving the collected solid bodies of material from the hoppers 498 and 491 of hold 135. Screw conveyor mechanisms (not shown) similar to those previously described are operatively associated with the discharge openings of hopper portions 490 and 491 for positively displacing the solid bodies of material from the hopper portions to conduit portion 560.

As seen particularly in FIGS. 6 and 1', conduit portion 560 includes a downwardly facing open end 562 which is open to the sea water, a valve 563 being provided in this conduit portion for controlling the flow of sea water therethrough. The opposite end portion of conduit portion 560 is in communication with the pump 533, a valve 565 being provided for controlling the flow of the sea water and solid body mixture therethrough.

As seen in FIG. 5, the port tanks 567 correspond to those shown in FIG. 4, and contain salt water ballast.

The tanks 568 on opposite sides of the ship adjacent to the pump room comprise fuel oil tanks as do the tanks 569 on opposite sides of the ship adjacent the bow portion. The starboard tanks 570 correspond to those shown in FIG. 4 and contain salt water ballast.

The pump 533 is provided with a discharge conduit line 572 which as seen most clearly in FIGS. 1'-1" and 2'-2" extends upwardly from the pump means at the starboard side of the ship and then extends along the starboard portion of the hull to a fitting 574 provided at the stern of the ship. This fitting is interconnected with a floating conduit means indicated generally by reference numeral 575, this floating conduit means including a flexible hose portion 577 formed of a suitable abrasion resistant water proof material such as rubber or the like, this hose being surrounded by spaced float members 578 formed of a suitable buoyant material such as polyurethane or the like which may be covered with rubber or a similar material. This floating conduit means is adapted to float on the surface of the water when in its operative position and is adapted to be stowed when in its inoperative position along the starboard portion of the ship as indicated particularly in FIGS. 2'-2" at approximately the upper deck level, and being maintained in such operative position by any suitable attaching means.

**Operation of mining ship storage system**

During normal mining operations, the mixture of solid collected bodies and sea water will be continuously moved upwardly through the conduit means from the collecting means travelling along the sea bottom and this mixture will be discharged into the separating means 130. The solid bodies which are separated out by means 150 are
then moved forwardly along the conveyor means 132 or rearwardly along conveyor portion 346 to the hatch means 345, 348, 349 or 350 as the case may be. The various sea water and one cargo hold receives the collected solid bodies at a time. Assuming that it is first desired to fill the aft cargo hold 135, the solid bodies separated out by separation means will be transferred by the conveyor portions to the hatch means 345, from whence the solid bodies will drop directly into the hold 135.

The water within the hold will serve to cushion the fall of the solid bodies of material such that they will not have a tendency to shatter against the hard surfaces of the hopper portions at the lower part of the hold, and overflow means 580 as seen in FIG. 1 is provided for permitting the water within hold 135 to overflow as it becomes filled with solid bodies of material. Similar overflow means 581, 582 and 583 are associated with holds 136, 137 and 138 respectively.

After hold 135 has been substantially completely filled with solid collected bodies, the solid bodies are then carried by the conveyor means forwardly to the next hold 136, and suitable gate means is then provided for discharging the solid bodies from the conveyor means 132 into the hatch means 348. This procedure is followed until all of the holds have been filled with solid bodies. A further advantage of the provision of sea water in each of the holds which is adapted to overflow as the holds are filled is the fact that the draft of the ship will remain substantially constant with a minimum amount of deballasting of tanks 567 and 570 during this filling operation which is of course a very desirable feature. In other words, the draft of the ship will not be substantially altered as it becomes loaded with collected solid bodies of material.

**Operation of cargo transfer system**

The mining ship 110 previously described will periodically become substantially completely filled with solid collected bodies, and in order to maintain continuous mining operation, it will be necessary to transfer the collected bodies to another ship. The discharge system including the various screw conveyor mechanisms and the associated conduits which are connected with the pump means are utilized for emptying the various holds and for transferring the collected solid bodies of material to an associated ship.

Referring now particularly to FIG. 3, the general arrangement of the transfer of the cargo from the ship 110 previously described to a suitable cargo ship 585 is illustrated. In order to carry out the transfer operation, the cargo ship 585 which may be of conventional construction and provided with a large cargo carrying capacity is operatively connected with the mining ship 110 by means of a towing cable 587 of conventional construction. The mining ship may continue its usual mining operation while towing the cargo ship therefrom through the intermediary of the towing cable. The floating conduit means 575 previously described is connected between the mining ship and the cargo ship and is adapted to float on the surface of the sea.

It will be understood that the cargo ship 585 is provided with a suitable conduit system such that it is adapted to receive a mixture of sea water and solid collected bodies from the floating conduit means and to transfer this mixture to various holds where the major portion of the sea water will be eliminated and the solid bodies will be collected.

Once the mining ship and the cargo ship have been operatively connected as indicated in FIG. 3, the transfer operation can commence. One hold at a time will be emptied from the mining ship, and assuming that it is first desired to empty hold 138, valves 557 and 558 are opened and the pump 533 is energized so as to suck sea water in through the intake portion 556 of conduit portion 552.

At the same time, the collected solid bodies are transferred from the hopper portions 510 and 513 of hold 138 to the longitudinally extending conduit portion 552 by means of the screw conveyor mechanisms and 554 which are continuously operated at a metered rate. In other words, the six screw conveyors operatively associated with hold 138 are operated to provide uniform discharge of the solid bodies from the hold into the conduit portion 552.

The flow of sea water induced through the conduit portion 552 by the pump will cause the solid bodies to be entrained in the sea water, this mixture of sea water and solid bodies will then be transferred through the discharge line 572 to the floating conduit means 575 and thence to the cargo ship 585.

After hold 138 has been emptied of solid collected bodies, the hold is again filled with sea water and is ready to receive newly collected bodies of solid material from the conveyor mechanism 142 on the deck of the mining ship.

It is apparent that the various holds in the mining ship can be emptied in the foregoe manner and transfer of the collected solid bodies within the holds can be effected to the cargo ship through the intermediary of the various conduit portions associated with the hopper portions of each of the holds. It is of course evident that the valve means associated with these conduit portions will be selectively actuated so as to direct the bodies to be evacuated in the desired sequence, and the flow of the mixture through the conduit means may be controlled through the intermediary of these valve means.

The present invention also contemplates another concept in the manner of storing and transferring the collected solid bodies of material. In this second concept, suitable equipment is provided on the mining ship for crushing and drying the solid bodies of material as they are brought up to the ship and are separated from the sea water. A suitable crushing mill mechanism and drying oven may be utilized for accomplishing such end result. The crushed and dried particles may then be transferred to the holds of the mining ship by means of a suitable conveying mechanism.

When it is desired to subsequently transfer the crushed and dried particles to a cargo ship, a fluidized system will be provided with suitable pump means whereby the dry particles may be pumped in a fluidized state through suitable conduit means to the cargo ship.

Referring now particularly to FIG. 12, the general arrangement and interrelationship of the ship structure including the well portion, the overhead crane and the stowage means is illustrated. As seen in this figure, access is gained to the stowage means through the hatch 443. Within the stowage means there is disposed upper support means 642 and lower support means 658 which is adapted to support individual sections of the conduit means, one of such sections being indicated by reference numeral 590.

Turntable track portions 677 are provided at the end of track means in the upper portion of the stowage means, and a stowage area housing means 720 is mounted for movement along these tracks for moving the individual pipe sections within the stowage area to and from the access hatch 443.

A plurality of guide rails 687, 688 and 689 are disposed beneath the access hatch 443 for guiding the movement of conduit sections through the access hatch, and a movable guide portion 691 is provided for sliding movement along the guide rails. It is apparent as seen in phantom lines in this figure that the conduit sections can be lifted or lowered with respect to the access hatch and the stowage area by means of the overhead crane means.

**Movable support means**

Referring particularly now to FIGS. 12 through 17 inclusive, the movable support means includes a body means of rigid heavy-duty construction, this body means comprising a plurality of frame members which may be of I-beam cross sectional configuration, these various
frame members being rigidly interconnected with one another as by welding or the like. As seen most clearly in FIG. 13, the framework 814 and 815 define a substantially V-shaped cutout portion as indicated by reference numeral 817 at the forward past of the movable support means, this V-shaped cutout portion being adapted to receive a part of the truss means as will hereinafter appear while lifting and lowering the truss means into and out of operative mining position. As seen in FIG. 13, a removable plate member 818 is disposed at the apex portion of the V-shaped cutout in the body means and may be removed when desired.

A first pair of frame members 820 and 821 extend along the port side of the support means, and a similar pair of frame members 822 and 823 extend along the starboard port of the support means. A rear cross frame member 825 extends between the end portions of the frame members 821 and 823.

A pair of cross frame means are indicated generally by reference numerals 827 and 828 and may comprise a single cross frame member or a plurality of sections as illustrated in FIG. 13, the framework of such sections 830, 831 and 832 as illustrated, and cross frame means 828 including three sections 834, 835 and 836 as illustrated.

A first pair of longitudinally extending brace frame members 838 and 839 extend between the cross frame means 827 and 828, while a second pair of longitudinally extending cross brace members 829 and 830 extend between the cross frame means 828 and the rear cross frame member 825. This over-all arrangement provides a very substantial and rigid framework, the entire framework being moved by a top plate means indicated generally by reference numeral 842.

Four flanged wheels indicated by reference numerals 844 are disposed at the port side of the support means, and four similar wheels 845 are disposed at the starboard side of the support means. These wheels are all rotatably journalled in conventional manner for rotation with respect to the support means, these wheels being suitably spaced with respect to the spaced portions of the guide track means on the deck such that the movable support means will always remain in supported guided relationship with respect to the guide track means.

A second plurality of bracket means indicated by reference numerals 847 are provided on the upper surface of the top plate means of the movable support means for interconnection with and supporting certain parts of the truss means when moving the truss means into or out of operative mining position. A second plurality of bracket means indicated by reference numerals 848 are provided on the upper surface of the plate means and are adapted to engage certain portions of other parts of the underwater mining equipment such as the buoyancy capsule and the like. In addition, a plurality of foundation members indicated by reference numerals 850 are provided on the upper surface of the top plate means for supporting a part of the underwater mining equipment as for example the dead weight means.

A central hole 852 is provided through the upper plate means, and it will be noted that the various frame members are offset with respect to this hole such that an opening is provided through the central portion of the body means through which certain parts of the mining equipment may extend. Clamping means is mounted in overlying relationship to this opening through the body means the clamping means including a pair of clamping members indicated generally by reference numerals 854 and 855. The clamping members include upper engaging portions 856 and 857 respectively which are adapted to engage and support portions of the underwater mining equipment, these engaging portions being illustrated as comprising substantially semicircular portions which in the present invention are adapted to engage the outer portions of an associated conduit section for holding the conduit section in the operative relationship as will hereinafter appear.

As seen in FIG. 13, the uppermost portions of clamping members 854 and 855 terminate at points 856 and 857 to define a gap therebetween while the upwardly facing engaging portions 856 and 857 extend to substantially abutting relationship with one another and define side surfaces 858 and 859 which as seen in this figure taper inwardly toward one another. The spaces between portions 856 and 857 is adapted to receive the electrical power and television cables associated with the underwater equipment as well as the air pipe extending upwardly from the dead weight means as described hereinbefore. The sloping surfaces 858 and 859 will serve to cam the flexible cables outwardly as the clamping portions are moved together and ensure that the cables will not be pinched between the clamping portions as they come together.

Guide means is provided for guiding the moving of said clamping members toward and away from one another, the guide means including first pairs of rollers 860 and 861 at one frame of the clamping means 854 and 855 respectively, and second pairs of rollers 862 and 863 provided on the opposite side of the clamping members 854 and 855 respectively. A first pair of guide rails 865 and 866 supported on plate 842 are provided for operatively cooperating with the guide rollers 860 and 862 of clamping member 854 to guide the movement of the clamping member with respect to the body means. A second pair of guide rails 868 and 869 are provided for cooperating with the rollers 861 and 863 of the clamping member 855 to guide the movement of the clamping member with respect to the body means.

Referring now particularly to FIG. 17, a means for locking the rollers of the clamping means in operative position is illustrated, it being understood that all of these locking mechanisms is associated with each of the roller means, the particular locking mechanism illustrated being associated with the roller means 863.

As seen in FIG. 17, a cutout portion 870 is provided in the upper plate means 842 and a support portion 872 is disposed within this cutout portion and has a clearance therewith for movement in an upward and a downward direction. Support portion 872 also includes an upwardly extending guide rail 873 which is aligned with the guide rail 869 supported on the upper plate means 842.

A bracket means 875 is disposed in depending relationship from the adjacent frame member 835, this bracket member including wall portions 877 within which is seated a compression spring 878. It is apparent that the spring 878 will normally hold the support portion 872 in its position as shown in FIG. 17 wherein the upper surface thereof is substantially flush with the upper surface of the adjacent plate means 842. The spring means such as 878 of the various locking mechanisms is of sufficient strength to maintain the associated support portions such as 872 in their up position as shown when the rollers are supported thereon, and accordingly, the springs will normally support the weight of the clamping members. On the other hand, when the clamping members are under load when supporting a part of the underwater mining equipment, the support portion 872 will be moved downwardly to the dotted line position. It is apparent that the support portion has been so moved downwardly, the associated supported roller means 863 will be prevented from rolling back toward the inoperative position and will accordingly be maintained in its forward clamping position until the load is removed from the clamping members, whenupon the spring means will again urge
the support portion 872 upwardly to its original upward position and the clamping members can be withdrawn. Additional guide means for the clamping members as shown more clearly in FIG. 15 include such frame members serving to additionally guide the clamping members in their movement into and out of clamping position. Power operated means in the form of hydraulic rams includes a lower hydraulic cylinder 885, the piston of which is connected with clamping member 854 by means of a connecting rod 884. An upper hydraulic cylinder 885 includes a piston which is connected with clamping member 854 by a connecting rod 886. Similar hydraulically operated means is operatively connected with clamping member 855 and includes a lower hydraulic cylinder 890, the piston of which is connected by means of connecting rod 891 with clamping member 855. An upper hydraulic cylinder 893 includes a piston which is connected with the clamping member 855 by a connecting rod 894. It will be noted that the lower hydraulic cylinders 885 and 890 are much larger than the upper hydraulic cylinders 885 and 893. The upper hydraulic cylinders 885 and 893 are fast acting cylinders adapted to provide clamping members through a substantial distance of travel rather quickly, while the lower cylinders 883 and 890 are slow acting cylinders adapted to apply clamping pressure to hold a supported under-water mining equipment component in operative clamped position between the clamping members.

It is apparent that the power operated hydraulic ram means are adapted to move the clamping members into and out of operative clamping relationship with respect to one another, any suitable control means being provided for controlling the operation of these hydraulic rams. As seen particularly in FIG. 13, an electric motor 896 is supported by the body means and is operatively connected with a hydraulic pump 897 which in turn is connected in the usual manner with the sump tank 898. The pump 897 is operatively connected by suitable conduit means with each of the hydraulic rams means, the aforementioned control means being connected in such conduit means for controlling the operation of the rams means. The hydraulic pump 897 is also connected with a conventional hydraulic motor 900.

Hydraulic motor 900 is supported beneath the top plate means of the body means and is connected by a drive shaft means 902 with a speed reducer means 903. A conventional brake mechanism is indicated at 904 and may be controlled by hand for applying the brake when desired.

The output of the speed reducer means 903 is connected with a driving shaft 905 the opposite end of which is rotatably supported in a bearing means 906 supported by a downwardly extending bracket 908. A pair of drive sprockets 910 and 911 are connected with space portions of the drive shaft 905. A longitudinally extending frame support member 913 is supported between FIG. 15 frame means 828 and rear cross frame member 825 and supports a pair of sprocket bearings 914 and 915. A drive shaft 917 is supported between bearing 915 and a bearing 918 supported at the port side of the movable support means, and a similar drive shaft 920 is supported between bearing 914 and a bearing 921 provided at the starboard side of the movable support means. Sprockets 910 and 911 are operatively connected respectively with the drive shafts 920 and 917. A first chain driving connection 923 is provided between sprocket 910 and a sprocket 924 fixed to shaft 920, and a second driving chain connection 925 is provided between sprocket 911 and a sprocket 926 fixed to shaft 917. In this manner, drive is transmitted from the drive shaft 905 to each of the drive shafts 917 and 920 which have respectively the sprockets 927 and 928 operatively secured to the outer ends thereof.

The sprockets 927 and 928 at opposite sides of the movable support means are adapted to cooperate with means such as length of roller chain means thereby indicating by reference numerals 930 and 931 which can be suitably secured as by welding to the upper surface of the deck means. The intercooperation between the fixed roller chain means and the rotating sprockets 927 and 928 serve to provide a means for positively driving the movable support means fore and aft of the ship.

The guide track means 458 and 460 previously described are provided at the port and starboard sides respectively of the movable support means and serve to support and guide the wheels of the movable support means in the movement of the movable support means fore and aft of the ship.

Wedge locking means is provided for selectively locking the movable support means in a particular position relative to the deck. A first pair of spaced wedge bearing portions 934 and 935 are provided at the port side of the body means and a second pair of spaced wedge bearing portions 937 and 938 are provided at the starboard side of the body means. Each of these wedge bearing portions has a substantially channel-shaped cross sectional configuration as seen in FIG. 14 and further as seen in FIG. 15, the downwardly facing surface of the central portion of each of these channel-shaped bearing portions slopes downwardly from the outer side of the movable support means toward the inner portion of the movable support means.

The wedge locking means also includes a plurality of wedge members 940 each of which has been given the same reference numerals since these wedge members are of identical construction. The wedge members each include an upwardly facing surface 941 which slopes downwardly and inwardly toward the inner portion of the associated movable support means so as to fit snugly against the aforementioned downwardly facing surface of the wedge bearing portions. These wedge members are each connected with an enlarged body portion 943 which in turn is supported by means of four roller members 944 rotatably supported at spaced side portions of this wedge portion. The rollers are adapted to roll along inclined portions 945 supported by the deck.

A pair of spaced upwardly extending guide members 946 are provided on the deck in association with each of the wedge members and is adapted to engage opposite sides of the wedge members for guiding them in their movement into and out of wedge locking relationship with the wedge bearing portions on the body means.

As seen particularly in FIG. 13, a first pair of upstanding lugs 947 are supported on the deck and serve to pivotally support a wedge locking lever 948 on a pin means 949 extending between the lugs. A second pair of upwardly extending lugs 950 are supported by the deck and are adapted to receive the opposite end of the locking lever therebetween, the lugs 950 and the locking lever being provided with openings which are adapted to be aligned with one another so as to receive a locking pin 951 therethrough for holding the locking lever in its locking position.

The locking lever is provided with a portion 952 thereon which is adapted to cooperate with a portion 953 on the part 943 of the wedge member, these two interengaging portions 952 and 953 being provided with complementary surfaces. When the locking lever is in the position shown in full line in FIG. 15, the wedge members
are at their inner limit of movement in engagement with the wedge bearing portions on the body means, and outward movement of the wedge members is positively prevented. On the other hand, the wedge locking levers may be swung into the phantom line position as shown in FIG. 13 whereupon each of the associated wedge members may be withdrawn outwardly away from the wedge bearing portions on the body means.

The wedge members may be moved into the operative locking position by any suitable means. As seen particularly in FIG. 15, wedge bearing plates 955 are disposed beneath the wedge members when the wedge members are moved inwardly thereby supporting such wedge members. The intercooperation between the sloping surfaces formed on the wedge bearing portions of the body means and the upper surfaces of the wedge members serves to lift the body means upwardly to lift the wheels of the body means off of the associated track and to also raise the driving sprockets 927 and 928 out of interengagement with the drive portions 930 and 931 secured to the deck. It is accordingly apparent that when the wedge members are in this position, the movable support means will be positively prevented from moving along the deck.

As seen in FIG. 15, each of the wheels 844 and 845 disposed at the port and starboard side respectively of the barge is adapted with the articulating means and the wheels and flanges thereof normally cooperates with the guide track means to properly guide movement of the movable support means. The wedge bearing plate 955 is each provided with a cutout portion 957 which is adapted to receive this vertical flange portion of the associated wheels so as to permit the wheels to freely pass over the upper surface of the wedge bearing plate portions, the upper surfaces of which are flush with the adjacent guide track portions.

Referring again to FIG. 13, it will be noted that a pair of removable plate portions 959 and 960 are provided, these removable plate portions being supported on the upper portion of the frame means and permitting operating personnel to gain access to the clamping members and any equipment which may be supported thereby. These removable plate members may be taken away when it is desired or necessary to have a full clearance of the opening provided in the body means.

Also as seen in FIG. 13, the movable support means is provided with laterally extending towing pins 961 extending outwardly from the central web of frame members 820 and 822 at opposite sides of the movable support means. These towing pins are utilized for towing the pumping means dolly hereinafter described.

**Pumping means dolly**

Referring now particularly to FIGS. 18, 19 and 20, the dolly means utilized for supporting the pumping means in a stowed position and for moving certain components of the equipment into desired operative position is illustrated. This dolly means includes a body means formed of an open framework comprising a plurality of interconnected rigid members which are preferably of I-beam cross sectional configuration. The body means includes two frame members 962 and 963 extending generally athwartship, these two frame members being interconnected by fore and aft frame means 965 and 966, the port frame means 965 including a pair of frame members 968 and 969 of I-beam cross sectional configuration secured to one another, and the starboard frame means 966 including a pair of frame members 970 and 971 of I-beam cross sectional configuration secured to one another.

Four spaced wheels 973 are supported by the port frame means 965, and four similar spaced wheels 975 are supported by the starboard frame means 966. These wheels are adapted to move along the track portions 458 and 460 as seen particularly in FIG. 19 whereby the dolly means is supported and guided in its movement along the deck.

**Auxiliary support means**

Referring now particularly to FIGS. 21 through 24 inclusive, the auxiliary support means of the present invention comprises a pair of movable portions indicated generally by reference numerals 1014 and 1015. Each of these movable portions comprises an open framework type construction formed of heavy tubular members for maximum strength and rigidity, the movable portion 1014 including a pair of members 1017 and 1018 which converge toward one another and which are secured at the upper ends thereof to a support portion 1023. A cross member 1022 is fixed at its opposite ends to an intermediate portion of members 1017 and 1018 to provide a reinforced A-frame construction.
The movable portion 1015 in a like manner includes a pair of members 1024 and 1025 which are secured at the upper ends thereof to a support portion 1026, a cross member 1027 being secured to intermediate portions of members 1024 and 1025 for reinforcing the structure and to provide an A-frame construction. All of the various members of the two movable portions may be suitably fixedly secured to one another as by welding and the like.

Referring now particularly to FIG. 23 which is a view looking up into the well portion from the bottom of the shaft means as shown in the figure it will be noted that the substantially rectangular shaped well portion indicated by reference numeral 125 includes a plurality of walls which define a central well area through which the various underwater components pass during lowering of the equipment into mining position and raising of the equipment from mining position. An aft wall portion 1030 defines the aft part of the well area, and is formed so as to define the cutout portion 1031, it being noted that the side wall portions 1032 and 1033 taper downwardly and outwardly from the top portions 1032* and 1033* respectively thereof to the lower portions 1032* and 1033* respectively thereof, outwardly extending portions 1035 and 1036 being provided for supporting in combination with the lower parts of said side wall portions the tubular parts 1039 and 1040. These tubular parts are mounted for pivotal movement by means of suitable bearing means indicated at 1041 and 1042, being connected to the lower ends of members 1017 and 1018 of the movable portion 1014.

At the opposite side of the well portion as seen in FIG. 23, wall portions 1045, 1046, 1047, 1048 and 1049 define the forward extent of the well area, the wall portions 1045 and 1049 being recessed as indicated at 1052 and 1053 respectively to provide clearance for the members 1024 and 1025 of the movable portion 1015. Outstanding portions 1055 and 1056 serve to cooperate with wall portions 1045 and 1049 respectively to rotateably support tubular portions 1058 and 1059 on bearing means indicated at 1060 and 1061. These tubular portions 1058 and 1059 are secured respectively to the lower ends of the members 1024 and 1025 of the movable portion 1015 whereby this movable portion is pivotally supported for movement with respect to the well portion.

The walls portion 1064, 1065, 1066, 1067, 1068 and 1069 cooperate with the elevator guide portion 1070 to define the starboard extent to the well area, and the wall portions 1072, 1073, 1074, 1075, 1076, 1077, 1078, and 1079 cooperate with the elevator guide portion 1080 to define the port extent of the well area. The movable portions 1014 and 1015 are adapted to be pivoted upwardly into the recess portions provided adjacent the well area so as to provide a substantially unobstructed central well area through which the mining equipment can be lifted and lowered. It will be noted however, that each of the movable portions is normally stowed in a recessed portion of the well area as aforementioned, and accordingly the movable portions can be completely removed from the well area by detaching the bearings from the associated tubular portions to thereby permit complete removal of these movable portions.

Means is provided for pivoting the movable portions 1014 and 1015 into and out of operative supporting position. The support portions 1020 and 1026 are provided with radially outwardly extending lugs 1082 and 1084 respectively which are secured to one end of cables 1058 and 1086 respectively. These cables are in turn secured on cables 1095 and 1096 respectively which are connected with drive shafts 1093 and 1094 therefor which are in turn connected to bevel gears 1095 and 1096 respectively. The driving shafts are in turn adapted to be driven by hand wheels 1098 and 1099 respectively which are connected with vertically extending shafts 1102 and 1103. These shafts are adapted to be removed and are interconnectable with resected fittings provided in the deck, these recessed fittings in turn being connected with bevel gears 1104 and 1105 which mesh with the gears 1095 and 1096 respectively.

It is apparent that by inserting the hand wheels and associated shafts into the fittings and turning the hand wheels, the movable portions 1014 and 1015 may be pivotally retracted or fixedly secured in retracted or inoperative position in phantom lines in FIGS. 21, 22 and 24.

As seen particularly in FIGS. 21 and 22, the support portions 1020 and 1026 are respectively provided with recessed or cutout areas 1107 and 1108 which define upwardly facing surfaces 1107* and 1108* which actually engage and support certain portions of the underwater mining equipment such as the flanges or collars provided on the individual conduit sections. Each of these cutout portions or recesses is substantially arcurate in configuration so as to substantially conform to the shape of the flanges or collars on the conduit sections. A conduit section is illustrated in phantom lines in FIGS. 21 and 22 in a typical supported position with respect to the movable portions of the support means.

Locking means is provided in the form of a pair of arms 1110 and 1111 as seen particularly in FIG. 23 for example, these arms each being pivotally supported as indicated at 1112 and 1113 on the support portion 1020 and being movable into contacting relationship with the support portion 1026 and secured in operative position by suitable lock pins indicated by reference characters 1115. When the locking means is in this locked position, it serves to prevent the support portion from separating from one another thereby holding the support portion in the operative supporting position at the central part of the well. When it is desired to release these locking members, the pins 1115 are removed and the support means 1026 is withdrawn away from the support means 1026 thereby permitting free pivotal movement of the movable portions 1014 and 1015.

Supported within the well portion below the auxiliary support means described above is a snubber means indicated generally by reference numeral 1120. This snubber means includes a collar means comprising a pair of substantially semi-cylindrical portions 1121 and 1122 which have radially outwardly extending flanges 1123 and 1124 respectively formed at opposite ends thereof. These flanges are adapted to be placed in abutting relationship with one another and detachably secured together by suitable nut and bolt assemblies such that when the over-all arrangement of the snubber means is in its operative
position, the cables 1131 and 1140 are aligned with one another and disposed at 90° angles to the cables 1134 and 1137 which are also aligned with one another.

It will be noted that the snubber means is particularly adapted for use for engaging the lower part of the conduit section when such conduit section is supported by the auxiliary support means previously described, this overall arrangement being shown in FIGS. 21 and 22. The two portions of the collar means are adapted to be snugly clamped about the outer surface of the conduit section and to hold this part of the conduit section from movement relative to the walls of the well portion. The particular manner of use of the auxiliary support means as well as the snubber means will be described in detail hereinafter.

Elevator operating mechanism

Referring now particularly to FIGS. 25 through 30 inclusive, the means for lifting and lowering the elevator means 128 may be most clearly understood. The elevator means as seen in FIGS. 25, 26 and 27 is illustrated in its topmost operative position. As seen in these figures, four fixed sheave members 1150, 1151, 1152 and 1153 are supported at the port side of the ship by the superstructure previously described. Four similar fixed sheave members 1155, 1156, 1157 and 1158 are supported at the starboard side of the ship by the superstructure. Any suitable mounting and support means may be employed for supporting these sheave members in the proper operative position, an open type truss framework being provided for this purpose as seen in these figures.

The drive mechanism for the lifting and lowering means includes an electric motor 1160 which drives a hydraulic pump 1161, the motor and pump being supported on the deck means 1162. The hydraulic pump is in turn operatively connected by suitable conduit means with a hydraulic motor 1165. This hydraulic motor is operatively connected with speed reducer mechanism 1166 which also has a hydraulic brake mechanism 1167 associated therewith for stopping the drive mechanism when desired. The output of the speed reducer mechanism is connected with drive shafts 1170 and 1171 which in turn are operatively connected with gear boxes 1173 and 1174.

A first pair of vertically extending ball bearing screw members 1176 and 1177 are rotatably supported by the output of gear box 1173, and a second plurality of vertically extending ball bearing screw members 1178 and 1179 are rotatably supported by the output of gear box 1174. The ball bearing screw members 1176 and 1177 are supported at intermediate points by radial bearings 1182 and 1183 respectively, the upper ends of these ball bearing screw members being supported by thrust bearings 1184 and 1185 respectively. In a similar manner, the intermediate points of ball bearing screw members 1178 and 1179 are supported by radial bearings 1187 and 1188 while the upper ends of these last-mentioned ball bearing screw members are supported within the thrust bearings 1190 and 1191. The radial bearing means in each case may also include in association therewith a ball bearing spline means, the ball bearing screw and ball bearing spline means being of conventional construction and interacting with one another in the usual manner.

A first pair of sheave members 1193 and 1194 is operatively associated with ball bearing screw member 1176, similar pairs of sheave members 1195 and 1196, 1197 and 1198, 1199 and 1200 being operatively associated with the ball bearing screw members 1177, 1178, 1179 respectively. In each case, the upper sheave member of the pairs of sheave members is smaller than the lower sheave member, and a typical construction is shown in FIG. 30 wherein it will be seen that the ball bearing screw members 1176 and 1177 extend downwardly through central portions 1203 and 1204 of the sheave members 1193 and 1195 respectively to provide a threaded interconnection therewith. Each of the various sheave members is so interconnected with its ball bearing screw member such that upon rotation of the ball bearing screw members in one direction, the pair of sheave members associated therewith move away from one another, while rotation of the ball bearing screw member in the opposite direction causes the pair of associated sheave members to move toward one another.

A first cable means indicates generally by reference numeral 1207 is connected with one corner portion of the elevator means as best seen in FIG. 25 for example, this cable means being reeved over fixed sheave members 1150 and 1153 and thence downwardly within the protecting trunk portion 437, the cable means passing around the bottom movable sheave 1194 and thence upwardly over the movable sheave 1193, the cable means then being reeved around these sheave means and finally dead ended or fixedly secured to a dead end foundation beam 1208.

A second cable means indicated generally by reference numeral 1210 is connected with a second corner portion of the elevator means and is reeved over fixed sheave members 1151 and 1152 and thence downwardly within the protecting trunk portion 437, the cable means passing around the bottom movable sheave 1196 and thence upwardly over the movable sheave 1195, the cable means then being reeved around these sheave means and finally dead ended or fixedly secured to the dead end foundation beam 1208.

A third cable means indicates generally by reference numeral 1212 is connected to still a third corner portion of the elevator means and is reeved over fixed sheave members 1155 and 1158 and thence downwardly within the protecting trunk portion 438, the cable means passing around the bottom movable sheave 1201 and thence upwardly over the movable sheave 1200, the cable means then being reeved around these sheave means and finally dead ended or fixedly secured to a dead end foundation beam 1214.

A fourth cable means indicates generally by reference numeral 1216 is fixed to the fourth corner portion of the elevator means and is reeved over fixed sheave members 1156 and 1157 and thence downwardly within the protecting trunk portion 438, the cable means passing around the bottom movable sheave 1198 and thence upwardly over the movable sheave 1197, the cable means then being reeved around these sheave means and finally dead ended or fixedly secured to the dead end foundation beam 1214.

Means is provided for guiding the vertical movement of the movable sheave means, this means taking the form of a plurality of guide rails. As seen particularly in FIG. 30, the movable sheave means 1193 is provided with similar outstanding lug portions 1220 at the opposite sides thereof, a pair of such lug portions being provided on each side of the sheave means and defining a space therebetween. These lug portions receive within the space defined therebetween guide rail means indicated by reference numeral 1222 which may be of substantially T-shaped cross sectional configuration as illustrated.

It will be understood that each of the various movable sheave means is provided with similar lug portions 1220 and similar guide rails 1222 are provided for guiding the vertical movement of the sheave members. Accordingly, all of the various lug means and the various guide rails have been given the same reference numerals since they are of identical configuration and serve the same purpose.

Referring now particularly to FIG. 31, the elevator machinery room is indicated generally by reference numeral 1225, it being noted that the hydraulic motor 1165 and the speed reducer 1166 are supported by a deck means 1227. A motor controller mechanism 1228 is illustrated as being supported within the space 1230 of the machinery room between the deck means 1162 and the
deck means 1232. The motor controller mechanism is of conventional construction and operatively connected with the motor 1161 previously described for controlling the operation thereof. Ladders 1234, and 1235 are indicated as depending from the hatch portions 1236 and 1237 of the deck means 1162 and 1232 respectively.

The pumping means of the underwater mining equipment as previously referred to employs a separate motor and a separate pump mechanism therein. A spare motor for use in this pumping means is illustrated at 1240 and is supported on foundations 1241 which in turn rest upon the deck 1242. A spare pump for use in this pumping means is illustrated by the reference numeral 1245 and is supported upon foundation portions 1246 which in turn rest on deck 1242. A ladder 1247 depends from hatch 1248 provided in deck 1242.

Referring now to FIG. 27, a pair of girders 1250 are illustrated as being secured to the side of the well portion, a similar pair of girder members being secured to the opposite side of the well portion. These girder members extend inwardly toward the central portion of the well, and serve as limit stop means for limiting the downward movement of the elevator means within the well portion. A first pair of inwardly extending lock members 1252 are secured to the bulkhead defining the side of the well portion, and a second pair of spaced lock members 1253 similar to the first pair also extend inwardly from such bulkhead. Aligned holes 1254 and 1255 are formed through the lock members 1252 and 1253 respectively. Similar lock members are disposed in opposing relationship at the opposite side of the well portion to those shown. The aligned openings in the various lock members are adapted to receive lock pins which extend through suitable openings provided in portions of the elevator means adapted to fit between these lock members so as to positively lock the elevator at the level of said lock members. When the elevator is locked in operative position as indicated by phantom line 1257, the elevator is mounted in position for supporting underwater mining equipment thereon from gimbal means as hereinafter described while the underwater mining equipment is in operation.

Spaced above the lock members previously described are a first pair of similar lock members 1262 and a second pair of similar lock members 1263, opposing similar lock members being provided at the opposite side of the well portion at the same level. These last-mentioned lock members 1262 and 1263 are adapted to cooperate with the elevator means in the same manner as aforesaid so as to lock the elevator means in its normal stowed position as illustrated by phantom line 1265 when not conducting underwater mining operations.

A further pair of lock members 1266 are supported by the superstructure, and a similar pair of lock members 1267 are also supported by the superstructure. It will be understood that similar opposed pairs of lock members are supported from the superstructure at the opposite side of the well portion. These last-mentioned lock members 1266 and 1267 are adapted to cooperate with the elevator means so as to lock the elevator means in the position shown in full lines in FIG. 27 high above the deck, this position comprising a pumping means repair position for the elevator means as hereinafter described.

Elevator construction

Referring now particularly to FIGS. 31, 32, 33 and 34, the details of construction of the elevator means itself will be clearly understood. As seen particularly in FIG. 31, the body means of the elevator means comprises a substantially open framework composed of a plurality of members of I-beam cross sectional configuration which are rigidly interconnected with one another as by welding or the like. The framework includes a pair of elongated frame members 1270 and 1271 which extend athwartships and which are interconnected by fore and aft extending frame members 1272 and 1273. The outer ends of the frame members 1270 and 1271 define the four corners of the elevator means, the frame members being interconnected by the connection of the cable means 1207, 1210, 1212 and 1216 to these four corner portions being indicated in FIG. 31.

The framework also includes a pair of frame members 1275 and 1276 which extend athwartships and which have the opposite ends thereof secured to the frame members 1272 and 1273 respectively. Grating portions 1278, 1279, 1280, 1281, 1282 and 1283 are supported in their positions shown between the frame members for supporting personnel thereon to enable the components of the elevator means or underwater mining equipment supported thereby to be serviced. An electric motor 1285 is supported by the body means and is drivenly interconnected with a hydraulic pump means 1286 also supported by the body means. A drain sump tank 1287 is suitably interconnected by conduit means with the hydraulic pump means and the hydraulic ram means hereinbefore described which is operated by the pump means through suitable conventional means.

The guide means for guiding vertical movement of the elevator means includes the vertically extending guide portions 1070 and 1080 fixedly supported by the ship adjacent the well portion as previously described, these guide portions being disposed in opposing relationship. The roller means on the guide extending plates 1296 and 1297 and the guide portions for guiding vertical movement of the elevator may be seen most clearly in FIGS. 31 and 32, these roller means being mounted at opposite sides of the elevator and the roller construction being substantially identical. Accordingly, the roller support arrangement as has been given the same reference numerals at opposite sides of the elevator since the construction is identical and further since these roller mechanisms operate in the same manner.

A first pair of laterally extending plates 1290 are secured to the upper portion of the associated frame members 1272 and 1273 respectively at opposite sides of the elevator and a second pair of spaced lower plates 1291 extend from the lower portions of the associated frame members. A pair of vertically extending plates 1293 and 1294 are fixedly secured to the outer portions of the plates 1290 and 1291 previously described.

A pair of horizontally extending plates 1296 and 1297 extend outwardly from the associated frame member to which they are fixed, and horizontally extending bar-like members 1298 and 1299 are secured to the outer ends of plates 1296 and 1297 respectively, the bar members extending between and being secured to the vertically extending members 1293 and 1294.

A first support plate 1302 is secured to members 1293, 1294 and 1298 by any suitable means such as welding or bolts and the like. A second support plate 1303 is secured to members 1298 and 1299 by suitable means such as welding or bolts and the like. A third support plate 1305 is secured to members 1293, 1294 and 1299 by any suitable means such as welding or bolts and the like.

These three support plates are provided with openings therein which are adapted to receive and support journal portions 1307, 1308 and 1309 respectively.

The upper and lower journal portions 1307 and 1309 have outwardly extending arm portions 1310 upon which are rotatably supported roller means 1311 of essentially similar construction. These rollers are adapted to engage the bottom surface 1313 of the channel shaped elevator guide portions 1070 and 1080.

The journal portions 1308 supported by plates 1303 include outwardly extending shaft portions 1315 upon which are supported rollers 1316. Rollers 1316 are rotatably journaled by the journal portions 1308 and engage the side wall portions 1318 and 1319 of the channel shaped elevator guide portions 1070 and 1080, it being
apparent that the diameter of rollers 1316 is slightly smaller than the distance between the side wall portions 1318 and 1319 so that the rollers may roll against only one wall portion 1318 or 1319 at any one time. It is apparent that the rollers 1316 are mounted for rotation about axes which are substantially perpendicular to the adjacent rollers 1312, and it is evident that the rollers will interact with the vertically extending elevator guide portions 1070 and 1080 to assure that the elevator means moves upwardly and downwardly in the proper manner.

As seen particularly in FIGS. 32 and 33, gimbals support means comprises a first pair of plates 1321 and 1322 which extend along the bottom portion of the roller movements 1323 and 1324 as a means for securing the suspender means 1390 and 1391 to the support means 1344 and 1345.

It will be understood that the gimbals support structure has been specifically described as supported from frame member 1276. The gimbal support structure supported by frame member 1275 is of identical construction and has been given the same reference numerals primed.

The clamping means on the elevators means includes a pair of clamping portions indicated generally for reference numerals 1350 and 1351, these clamping portions being movably supported with respect to the elevator means and being movable over the central opening defined between the frame members 1275 and 1276 of the elevator framework. The two movable clamping portions are of substantially identical construction, and accordingly description of one of these movable portions will suffice, similar portions being given the same reference numeral primed in the other clamping portion. As seen particularly in FIGS. 32, 33 and 34, the clamping portion 1350 includes a support portion 1353 at the upper part thereof which comprises a flat horizontal member having an arcuate inner surface 1355 and a substantially L-shaped cross sectional configuration as seen in FIG. 32 such that a substantially arcuate recess portion 1356 defining an upwardly facing surface 1357 upon which various components of underwater mining equipment is adapted to rest and be supported. It should be noted that support portions 1353 and 1353' terminate at points indicated by reference numerals 1358 to define a space indicated at 1359 in FIG. 31 when the clamping portions 1350 and 1351 are in clamping position as indicated in phantom line, this space being adapted to receive the aligning lug 606 on a supported conduit section as aforesaid.

As seen particularly in FIG. 31, clamping members 1350 and 1351 terminate at the points 1363 and 1364 respectively which are adapted to define therebetwixt when the clamping members are in operative clamping position a space for receiving the electrical power and television cables as well as the aforesaid air pipe. These clamping portions also include the portions 1368 and 1369 respectively which extend toward one another and extend to be disposed in substantially abutting relationship when the clamping members are in operative clamped position. These latter portions 1368 and 1369 define sloping side surfaces as seen in FIG. 31 so as to create a clamping space when the two clamping portions are moved toward one another so as to pinch the electrical power and television cables therewith. Fixedly secured in depending relationship to the inner portion of member 1353 is a member 1360 having a substantially arcuate cross sectional configuration complementary to the arcuate inner surface 1358 of the member 1353. The arcuate cross section of member 1360 is adapted to fit snugly against the outer surface of an underwater mining component such as a conduit section to hold the conduit section in operative position with an upper flange thereof seated within the recess portion 1356 of member 1353.

Members 1362 and 1362' are of substantially T-shaped cross sectional configuration and members 1365 and 1365' as seen for example in FIG. 34 extend between points indicated by numerals 1366 as shown in FIG. 33 and form the support of clamping portions 1350 and 1351. Reinforcing gusset members 1370 and 1371 are connected between members 1362 and 1365. Gusset members 1373 and 1374 are connected between members 1362 and 1365 and 1375 and 1376 respectively. Gusset members 1390 and 1391 are connected between members 1362, 1353 and 1365. Gusset members 1392 and 1394 are connected between members 1362, 1365 and 1360. Gusset member 1325 is connected between members 1360 and 1365. The above-mentioned elongated plates 1375 and 1376 include depending plate portions 1375' and 1376' secured to the undersurfaces thereof between which are rotatably mounted wheel members 1380 and 1381 as seen in FIG. 33. These wheel members are adapted to roll along guide rails 1385 and 1386 secured to the upper surface of frame members 1275 and 1276 of the elevator means, the wheel members being provided with pairs of spaced flanges 1382 and 1383 for guiding and retaining the wheels on these guide rails.

A transversely extending plate 1396 extends rearwardly of member 1362 and is connected with a vertical extending member 1398. Power operated means in the form of hydraulic ram means includes a first lower hydraulic cylinder 1400 the piston of which is connected with a connecting rod 1401 which is connected to member 1398. The second upper hydraulic cylinder 1403 has hydraulic means which is connected with a connecting rod 1404 which in turn is connected with a rear portion of support member 1353.

It will be noted that hydraulic cylinder 1400 is much larger than hydraulic cylinder 1403. The second mentioned hydraulic cylinder is a fast acting cylinder which is adapted to move the clamping portion through a substantial distance of its travel rather quickly, while the first mentioned hydraulic cylinder is a slow acting cylinder which is adapted to apply clamping pressure to hold a supported underwater mining equipment component in operative clamped position of clamping portions. Any suitable control means may be provided for controlling the operation of the hydraulic ram means which is operatively connected with the hydraulic pump 1286 previously mentioned.

Gimbal means

Referring now particularly to FIGS. 35, 36 and 37, the construction of the gimbal means utilized for supporting the conduit means from the elevator means is specifically illustrated.

As seen in these figures, a pair of gimbal support means are indicated generally by reference numerals 1407 and 1408, gimbal support means 1407 including a pair...
of substantially semi-cylindrical halves 1410 and 1411, while the gimbal support means 1408 includes a similar pair of halves 1413 and 1414. Members 1410 and 1411 are attached to each other by bolts b as shown in FIGS. 35 and 36 extending within suitable openings provided in these members. Member 1411 includes a pair of laterally extending flanges 1417 at opposite sides thereof which have holes 1418 formed therefor for receiving suitable attaching means for securing the gimbal support means on the gimbal attaching members 1326 and 1327 previously described.

Members 1413 and 1414 are attached to each other by bolts b extending within suitable openings provided in these members. Member 1414 includes a pair of laterally extending flanges 1422 at opposite sides thereof which have holes 1424 formed therefor for receiving suitable attaching means for securing the gimbal support means on the gimbal attaching members previously described.

Referring to FIG. 31, the gimbal means is illustrated in supported operative position within the elevator means, and it will be noted that bolt assemblies 1426 and 1427 are support gimbal support means 1408 for attaching the gimbal support means to the two spaced underlying gimbal support members 1326 and 1327. In a similar manner, the other gimbal support means 1407 is attached to its associated gimbal support members on the elevator means by bolt assemblies 1429 and 1430.

Referring now particularly to FIG. 37, it will be noted that the two members 1410 and 1411 of gimbal means 1407 are of generally L-shaped cross sectional configuration and are adapted to support ball bearing means 1432 therewithin, a retaining plate 1434 being held in position at the ends of these members 1410 and 1411 by means of cap screws 1435.

In a similar manner, the two members 1413 and 1414 of gimbal support means 1408 are also of substantially L-shaped cross sectional configuration and serve to support ball bearing means 1438 which is held in place by the retaining plate 1439 supported on members 1413 and 1414 by cap screws 1440.

The gimbal means includes a first substantially annular portion 1443 which includes upstanding portions 1444 and 1445 from which extend the journal portions 1446 and 1447 respectively which are journalled within ball bearing assemblies 1432 of the two gimbal support means. With this arrangement, it is apparent that the annular member 1443 is journalled for rotation about a first pivot axis indicated by the line x—x.

Annular member 1443 also includes a pair of upstanding portions 1450 and 1451 which are disposed at substantially 90° relation to the portions 1444 and 1445. Each of the portions 1450 and 1451 may include lower and upper halves 1450' and 1450'', 1451' and 1451'', respectively which are adapted to be secured to one another by suitable bolt and bolt assemblies and the like indicated by reference numerals 1456 and 1457. With this arrangement, ball bearing assemblies similar to those previously described may be mounted with these portions and held in place by end plates 1459 and 1460 which are secured in place by suitable cap screws.

As seen particularly in FIG. 37, an annular member 1462 has a cylindrical conduit portion 1463 extending through the center thereof and rigidly secured thereto. The annular member 1462 has a pair of laterally extending journal portions 1464 and 1465 as seen in FIG. 35 which extend within the ball bearing means mounted in portions 1450 and 1451 of the first annular member. It is accordingly apparent that the second annular member 1462 is journalled for rotation about a second axis y—y which is substantially normal to the first axis x—x previously described.

Referring again to FIG. 37, the lower portion of conduit portion 1463 is secured to a flange portion 1467 having spaced holes 1468 formed therein corresponding in number to the holes provided in the upper flange of a typical conduit section such as 590 whereby flange portion 1467 can be rigidly secured to an associated conduit section. This arrangement serves to support the conduit means from the gimbal means.

The upper part of conduit portion 1463 is indicated as being rigidly secured to a portion 1470 which in turn may be connected with the flexible conduit portion 129 which transfers the collected solid bodies of material to the separation means 130 previously described.

It is evident from the foregoing description that the gimbal means is selectively removable from the elevator means and when in operative position therewithin is adapted to support the conduit means and the associated underwater mining equipment components. When the conduit means and the associated components are so supported, the conduit means is in effect connected with the elevator means by a universal connection due to the fact that the gimbal means permits rotation about two mutually perpendicular axes. This overall arrangement permits the conduit means to have the necessary movement with respect to the ship as is required during normal mining operations due to relative movements which will unavoidably occur between the underwater mining equipment and the ship thereof.

It is apparent from the foregoing that there is provided according to the present invention a new and novel ship structure and associated handling means for handling various components of the underwater mining equipment which is carried by the ship, the over-all combination being particularly adapted for carrying out mining operations at great depth beneath the surface of the sea.

At this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, and since the scope of the invention is defined by the appended claims, all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents are therefore intended to be embraced by those claims.

We claim:

1. Apparatus for use in underwater mining at great depths beneath the surface of the sea comprising a ship adapted to move the water over a particular mining area, said ship having wall portions defining a central well portion therein, said well portion opening upwardly for receiving mining equipment therethrough, said well portion also opening downwardly into the sea, support means including a plurality of movable portions, each of said movable portions having an upper end portion including a support portion for engaging and supporting parts of mining equipment disposed within the well portion, each of said movable portions having a lower end portion pivotally supported adjacent one of said wall portions whereby the upper end portions of said movable portions may be swung into and out of operative position in the central part of said well portion.

2. Apparatus as defined in claim 1 wherein said support portions are adapted to clampingly engage opposite sides of a conduit section, and means for selectively moving said movable support portions into and out of operative clamping position.

3. Apparatus as defined in claim 1 including locking means for holding said movable portions in operative supporting position within said well portion.

4. Apparatus as defined in claim 3 wherein said locking means comprises at least one member serving to interconnect said movable support portions, said last-mentioned member being selectively releasable.

5. Apparatus as defined in claim 3 wherein said well portion includes recess portions for receiving parts of said support means to provide an unobstructed well area.
through said ship for receiving components of underwater mining equipment.

6. Apparatus for underwater mining at great depths beneath the surface of the sea comprising a ship, said ship having a well portion therein opening downwardly into the sea, support means supported on said ship, said support means comprising a pair of movable portions, said movable portions being pivotally supported adjacent opposite parts of said well portion and being movable into and out of said well portion, each of said movable portions comprising an open framework having support portions at the upper part thereof for engaging parts of underwater mining equipment, means for moving said movable portions into and out of said well portion, said well portion including recess portions for receiving parts of said movable portions to provide an unobstructed well area through said ship for receiving certain underwater mining equipment components.

7. Apparatus as defined in claim 1 wherein each of said support portions includes a recessed area upon which the parts of the underwater mining equipment are adapted to rest, and one of said support portions including an additional substantially radially extending cutout portion for receiving certain parts of underwater equipment.

8. Apparatus as defined in claim 1 including snubber means in said well portion, said snubber means including a collar means adapted to engage portions of underwater mining equipment supported by said movable portions of the support means, and attaching means connected between said collar means and fixed portions of said ship for retaining said collar means in operative position.

9. Apparatus as defined in claim 8 wherein said collar means comprises a plurality of separate portions adapted to fit about underwater mining equipment, and means for securing said separate portions rigidly to one another.

10. Apparatus as defined in claim 8 wherein said attaching means is attached to peripherally spaced portions of said collar means for providing a substantially uniform support for said collar means.

11. Apparatus for underwater mining at great depths beneath the surface of the sea comprising a ship, said ship having a well portion therein opening downwardly into the sea, support means supported on said ship, said support means comprising a pair of movable portions pivotally supported by said ship adjacent opposite parts of said well portion, each of said movable portions comprising an open framework having support portions at the upper part thereof, each of said support portions including a cutout area for receiving parts of underwater mining equipment to be supported at the central portion of said well portion, means for pivoting said movable portions into and out of said well portion, locking means for retaining said movable portions within said well portion in operative supporting position to support underwater mining equipment at the central part of said well portion, said well portion including recess portions for receiving parts of said movable portions to provide an unobstructed well area through said ship for receiving underwater mining equipment components, and snubber means disposed within said well portion beneath said support means, said snubber means including collar means adapted to fit about underwater mining equipment components, and cable means connected between said collar means and fixed portions of said ship, said cable means being connected to peripherally spaced portions of said collar means to provide a uniform support therefor.

12. Apparatus for underwater mining at great depths beneath the surface of the sea comprising a ship adapted to move through the water, said ship including deck means, movable dolly means mounted for movement relative to said deck means, said dolly means including a body in the form of an open framework of rigidly interconnected frame members, wheel means rotatably supported by said framework and adapted to be mounted on track means on the deck of a ship for movement therealong, a plurality of spaced anti-roll stops fixed to the deck of the ship and spaced laterally outwardly of said track means and adapted to cooperate with said body means of the dolly to prevent undesired movement of the dolly in an athwartships direction, the body means of the dolly including means for supporting components of underwater mining equipment thereon, said dolly including outwardly projecting towing pin means adapted to engage a towing link whereby the dolly means is adapted to be moved along the tracks of the ship by means of a separate means which provides power for moving the dolly.

13. Apparatus for underwater mining at great depths beneath the surface of the sea comprising a ship, said ship having a well portion therein opening downwardly into the sea, support means supported on said ship, said support means comprising a pair of movable portions pivotally supported by said ship adjacent said well portion, each of said movable portions including support portions at the upper part thereof for engaging parts of underwater mining equipment, means for pivotally moving said movable portions into and out of said well portion from a remote location and for disposing said movable portions in such a position that said support portions are adapted to engage underwater mining equipment at the central part of said well portion, and locking means for holding said movable portions in operative supporting position within said well portion, said well portion including recess portions for receiving parts of said support means to provide an unobstructed well area through said ship for receiving components of underwater mining equipment.

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T. M. BLIX, Assistant Examiner.