A mooring system for a semisubmersible platform used for drilling in arctic waters wherein a self-powered mooring ring acts as a guide and support for a plurality of mooring cables anchored to the ocean floor at widely spaced points around the drill site. The mooring ring has ballast tanks and compressed air tanks, with remotely controlled valves to control the buoyancy of the ring. The ring is detachably secured to the platform and the cables detachably secured to mooring winches on the platform. The ring can be raised and lowered between the ocean floor and the bottom of the semisubmerged platform structure by remotely or manually controlling the buoyancy, permitting the ring and collar to be detached and lowered to the ocean floor when not in use, and later raised and attached to the platform when the platform is moved on location.

8 Claims, 7 Drawing Figures
MOORING SYSTEM FOR SEMISUBMERSIBLE DRILLING PLATFORM

FIELD OF THE INVENTION

This invention relates to a mooring system for a semisubmersible drilling platform or drill ship, and more particularly, is concerned with a mooring system which can be detached and stored on the ocean floor when not in use.

BACKGROUND OF THE INVENTION

Since the discovery of oil and gas in the arctic regions off the north slope of Alaska and the northern shores of Canada, there has developed a need for offshore drilling equipment capable of operating in the icy waters of the arctic region. This has given rise to the development of semisubmersible drilling platforms and drillships capable of operating in ice-covered waters. One such platform, described in copending application Ser. No. 459,029, filed Apr. 8, 1974, entitled Ice Cutter for Monopod Drilling Platform, and assigned to the same assignee as the present invention, is a monopod type structure in which a single supporting column extends between a submerged hull and an elevated platform. Drilling takes place through a moon pool extending from the deck of the platform down through the center of the single supporting column and opening in the bottom of the submerged hull. A comminuting ice cutting mechanism rotates about the outside of the supporting column to permit the platform to be moved through the ice or to permit the platform to remain stationary in the presence of moving ice.

In conventional practice, a semisubmersible drilling platform is maintained in position over the drill site by an anchoring system in which a plurality of anchors are secured to the ocean floor at spaced points around the drill site. Anchor chains and cables from the anchors are attached to and controlled by mooring winches on the platform so that, with changes in wind direction, currents and other forces acting on the platform to shift its position, the tension on the various cables can be adjusted to maintain the position of the platform substantially fixed during the drilling operation. The anchors are initially set in place by means of a workboat which drops each of the anchors at the widely-spaced selected anchor points. This must be done during the short summer season when the surface waters are relatively free of ice.

However, with the development of a platform capable of operating in ice-covered waters and capable of being moved from location to location through ice-covered waters, the conventional mooring practices described above have not proved adequate.

SUMMARY OF THE INVENTION

The present invention is directed to an improved mooring system for a semisubmersible drilling platform which operates in ice-covered waters. The mooring system of the present invention permits the anchor to be laid at a drill site during a time when the surface water is relatively free from ice while permitting the cables to be easily attached or detached from the semisubmersible platform at any desired subsequent time even when the drill site later becomes covered with ice.

In brief, this is accomplished by providing a mooring system which includes a self-powered mooring ring that acts as both a guide and support for mooring cables attached to widely-spaced anchors on the ocean floor. The mooring ring includes ballast tanks and compressed air tanks, with remotely controlled valves which control the buoyancy of the ring by admitting controlled amounts of air into the ballast tanks from the compressed air tanks. The ring is detachably secured to the platform and operates as a guide for the cables which are in turn detachably secured to drawworks on the platform. The ring can be raised and lowered between the ocean floor and the bottom of the submerged platform structure, permitting the ring and cable to be detached and lowered to the ocean floor when not in use and later raised and attached to the bottom of the platform below the ice and associated drawworks when the platform is moved on location.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the invention, reference should be made to the accompanying drawings, wherein:

FIG. 1 is an elevational view of the drilling platform and associated anchoring system before they are attached;

FIG. 2 shows the platform and mooring system after they are attached;

FIG. 3 is a fragmentary view partially in section of the mooring ring attached to the bottom of the platform;

FIG. 4 is a top view of the supporting column of the platform;

FIG. 5 is a side elevational view of the mooring ring;

FIG. 6 is a top view of the mooring ring; and

FIG. 7 is an enlarged partial view taken from FIG. 3, of the hawsepip entering the mooring ring of the present invention.

DETAILED DESCRIPTION

Referring to Figs. 1 and 2, the numeral 10 indicates generally a monopod type semisubmersible drilling platform having a lower submerged hull 12 to which is supported a deck 14 on which is mounted a drilling derrick 16. A single cylindrical column 18 supports the upper deck 14 above the surface of the water and ice from the submerged lower hull 12. The column 18 is provided with suitable rotating ice cutters 19, such as described in the above-identified copending application, for comminuting any ice encroaching on the supporting column and enabling the platform to move through surface ice, such as indicated at 20.

Before the semisubmersible platform is moved through the ice to the drilling location, part of the site preparation involves placing a plurality of anchors 22, preferably eight in number, at a plurality of widely-spaced positions on the ocean floor by means of a workboat. This is usually done in the summer when the open water permits the workboat to maneuver freely. Connected to each anchor is a length of anchor chain and/or cable 23 which is connected to a single mooring ring 24. As hereinafter described in detail, the mooring ring can be remotely controlled from the platform or other surface vessel to change the buoyancy of the ring by release of compressed air into ballast tanks. When not in use the mooring ring 24 has its ballast tanks flooded so that the ring sinks to the ocean floor. After the drilling platform is moved into location on the drilling site, compressed air carried in the mooring ring 24 is released into the ballast tanks increasing the buoy-
ancy of the ring sufficiently to cause it to rise toward the surface, lifting the anchor chain and cables 23 with it.

As shown in FIG. 2, the bottom of the lower hull 12 can be attached to the mooring ring 24. The cables are then attached to control winches or drawworks mounted within the platform 10 to control tension on each of the anchor chains so as to hold the platform in the desired position over the drill site.

The manner in which the mooring ring 24 is attached to the platform and the anchor chains is shown in FIGS. 3 and 4. The supporting column 18 includes an outer cylindrical wall 30 and an inner cylindrical wall 32. The inner cylindrical wall 32 forms a moon pool open to the water through which the drilling equipment passes from the derrick 16 down through the platform to the ocean floor during the drilling operation. When in operating position, the mooring ring 24 is secured to the bottom of the lower hull 12 by suitable grappling means, such automatic couplers that engage on contact between the mooring ring and hull bottom, with the central opening of the ring axially aligned with the moon pool. The cables attached to the anchor chains pass through hawsepipes, such as indicated at 34, extending from the lower outside surface of the mooring ring to the upper inside surface. Each cable then passes into a hawsepipe, such as indicated at 36, opening in the bottom of the lower hull 12 in the crescent-shaped space between the outer and inner walls 30 and 32 of the support column. The hawsepipes 36 extend from the bottom wall of the lower hull 12 up to a point well above the water level where the cables pass over pulleys, such as indicated at 38. The cables pass down again through the support column through hawsepipes 40 to associated winches 42 located in the lower hull 12. As shown in FIG. 4, each of the anchor cables passes around its own pulley and back down to the lower hull within the crescent-shaped space between the inner and outer walls 30 and 32 of the support column. Each anchor cable is controlled by its own winch, so that the tension on each cable can be individually controlled to maintain the proper position of the drilling platform. Alternatively, the cables may be brought up from the ring through the moon pool to mooring winches on the upper deck.

Details of the mooring ring are shown in FIGS. 5 and 6. The donut shaped ring is flattened at the top to provide a flat surface 50 which, as shown in FIG. 3, engages the bottom wall of the platform around the lower opening of the moon pool. By way of example, a typical mooring ring might have an outer diameter of 40 ft. or greater and a height of 12 ft., with an inner diameter of 17 ft. The inner and outer perimeters of the annular flat surface 50 are provided with concentric pressure seals 51 which press against the bottom of the platform when the mooring ring is locked in place. A plurality of stub connector pins 52 project up from the surface 50 for engaging mating locking connectors 53 in the bottom of the platform. With the mooring ring locked in position against the bottom of the platform, the annular space between the seals 51 is isolated from the sea water. This permits access to the interior of the mooring ring through the bottom of the platform for maintenance service and repairs. To this end, the top surface 50 is provided with a suitable manhole with a removable watertight hatch, as indicated at 54. A similar hatch in the bottom of the platform permits access to the interior of the mooring ring from the interior of the lower platform hull 12.

The interior of the mooring ring is preferably divided into four compartments by four bulkheads 56, 58, 60, and 62. Each compartment in turn is divided into an upper and lower region by a divider wall 64. The lower portion of each of the four sections forms a ballast tank, while the upper portion acts as a buoyancy tank and as a space for mounting the necessary operating equipment.

Each quadrant section of the mooring ring is provided with a pair of hawsepipes, such as indicated at 66 and 68. The hawsepipes 66 opens at one end adjacent to the upper interior surface of the ring, as indicated at 70. The hawsepipes is curved in an arc so that the other end opens in the lower outer surface of the mooring ring. Similarly the hawsepipes 68 terminates at the upper inner surface in an opening 74 and at the lower outer surface at an opening 76 which is substantially tangential to the surface. Thus the anchor chains enter the mooring ring substantially tangential to the surface of the mooring ring rather than radially. This arrangement provides better anchoring of the mooring ring and associated platform against rotational forces, such as produced by the torque of the ice cutters which are rotatably mounted on the outside of the supporting column of the platform.

Mounted within the buoyancy tank section of each quadrant of the mooring ring is a high-pressure tank 77 for storing compressed air. This tank is connected by an electrically controlled valve 78 to the associated ballast tank. When opened, the valve 78 releases air under pressure into the ballast tank forcing water out of the ballast tank through a flood valve 80 in the bottom of the associated ballast tank. Operation of valves 78 and 80 for controlling the buoyancy of the associated quadrant of the mooring ring is provided by a control unit 82 which responds to acoustic signals transmitted to the mooring ring and received by a hydrophone 84. In addition to receiving command signals from the platform or other surface vessel, the mooring ring includes a transmitting transducer 86 for transmitting position and attitude information to the controlling vessel. Each quadrant has its own hydrophone and transducer so that the buoyancy of the quadrant can be individually controlled from a remote point. The control unit 82 may also be operated by wire control from a surface buoy or manually by a diver or submarine.

The control circuit 82 responds to commands received on the hydrophone 84 as well as attitude sensors 88 mounted in the mooring ring. The attitude sensors, through suitable servo controls, operate the respective valves 78 and 80 in each of the quadrants so as to maintain the mooring ring substantially level in the water regardless of variations in the pull imposed by the anchor chains on the mooring ring as the ring moves between the ocean bottom and the bottom of the drilling platform. In response to commands received from the surface vessel over the hydrophone, the control circuit also controls the valves 78 and 80 in the respective quadrants to make the mooring ring rise, lifting the anchor chains off the bottom, or let the ring sink to the ocean floor. The ring can also be stopped at any intermediate level. The use of gravity type vertical sensors and hydrostatic pressure sensors to actuate a servo control system for controlling the buoyancy of the individ-
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usal ballast tanks involves conventional techniques which are well known in the art of servo control.

After passing through the hawsepipes 66 and 68, the ends of the anchor chains are provided with locking pins 69 which prevent the chains from pulling out of the hawsepipes as they are being lifted from the ocean floor by the rising mooring ring. After the mooring ring reaches the desired level, the platform is moved directly over the ring and the ring and platform are mated. At this time, the moon pool can be closed off at the top and the water forced out to the bottom of the collector ring permitting an operator to gain direct access to the lock pins on the anchor chains. In the alternative, rather than attempting to remove the water from the moon pool, a diver can be used. In either case, at the same time the locking pins are removed from the anchor chains, they are connected directly to the ends of the control cables going to the winches, permitting the tension on the anchor chains to be controlled by the winches 42. At any time it becomes necessary to move the platform off location, the cables can be disconnected from the anchor chains and the locking pins inserted to secure the ends of the chains to the mooring ring.

While the ring is attached to the bottom of the platform, the batteries for providing power within the mooring ring can be recharged and the air tanks can be recharged from the platform by suitable electrical and pneumatic connectors 90 and 92 in the top flat annular wall 50 of the mooring ring. After drilling operations are complete, the mooring ring can be commanded to rise to the surface where a workboat can retrieve the anchors and chains.

What is claimed is:

1. A mooring system for anchoring a semisubmersible drilling platform to the ocean floor, comprising:
   a mooring ring,
   a plurality of anchor cables extending from the mooring ring,
   anchor means connected to the cables for securing the cables at one end to the ocean floor,
   latch means for detachably locking the mooring ring to the drilling platform,
   means for releasing the latch means to separate the mooring ring from the platform,
   ballast tank means in the mooring ring, and means attached to the mooring ring controlling the amount of water in the ballast tanks to change the buoyancy of the mooring ring for raising and lowering the mooring ring between the ocean floor and the platform.

2. The apparatus of claim 1 wherein the mooring ring includes a plurality of hawsepipes, the mooring cables extending through said hawsepipes, and means mounted in the platform and attachable to the cables for control of tension on the cables from the platform.

3. The apparatus of claim 1 wherein the means controlling the water in the ballast tank includes means storing compressed air in the mooring ring, and remotely controlled valve means in the mooring ring for releasing air from the compressed air storing means into the ballast tank means.

4. The apparatus of claim 3 further comprising remotely controlled valve means for releasing air from the ballast tank means to flood the tanks with water.

5. The apparatus of claim 4 wherein the ballast tank means includes a plurality of separate tanks spaced around the mooring ring, each tank having separate remotely controlled valve means for controlling the effective buoyancy of each tank, whereby the attitude of the ring in the water can be controlled.

6. A mooring system for an offshore drilling vessel, comprising means defining an opening extending vertically through the bottom of the vessel, an annular mooring ring, latch means detachably securing the ring to the bottom of the vessel in coaxial relationship to said opening, means releasing the latch means to separate the ring from the vessel, a plurality of anchors, cable means attached to the anchors and extending into the opening in the vessel, the ring including guide means receiving the cable means to guide the cable means into said opening, and tensioning means mounted in the vessel for applying controlled tension on the cable means for positioning the vessel relative to the anchors.

7. Apparatus of claim 6 further including means for locking the cable means against movement relative to the guide means in the mooring ring, the tensioning means being detachable from the cable means so that the cable means is supported solely by the ring.

8. Apparatus of claim 7 wherein the ring includes ballast control means for changing the buoyance of the ring sufficiently to cause the ring to rise or sink in the water for raising and lowering the cable means.