United States Patent [19]

Helm et al.

[11] **3,766,874**

[45] **Oct. 23, 1973**

[54] **MOORED BARGE FOR ARCTIC OFFSHORE OIL DRILLING**

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[73] Assignee: **General Dynamics Corporation**, St. Louis, Mo.

[22] Filed: **July 29, 1971**

[21] Appl. No.: **167,296**

[52] **U.S. Cl.** .... **114/0.5 D,** 61/46.5, 114/40

[51] **Int. Cl.** **B63b 35/08**

[58] **Field of Search** .... 114/.5 R, .5 D, 40; 61/46, 46.5; 9/8 R, 8 P

[56] **References Cited**

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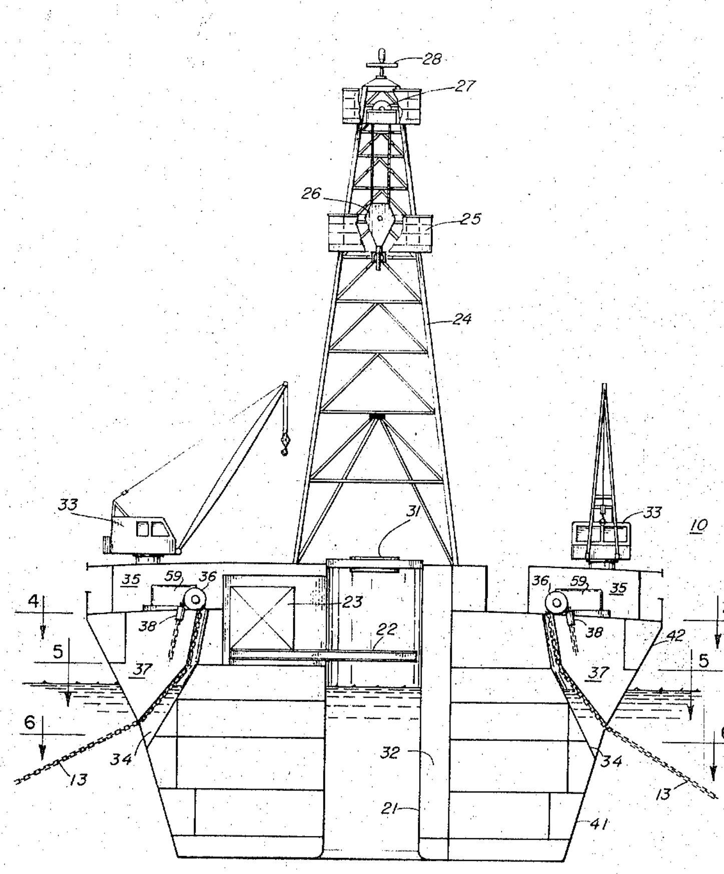
[57] **ABSTRACT**

A barge is provided for offshore oil drilling in Arctic waters. The barge is formed of two frusto-conical sections (with the points of the extended cones being pointed downward) with the lower section being steeper than the upper section. The angle of the upper cone serves to break ice impinging on the hull by riding up and breaking ice in bending. The hull is moored by lines connected at the line of joinder between the two conical sections, which is below the waterline.

1 Claim, 9 Drawing Figures



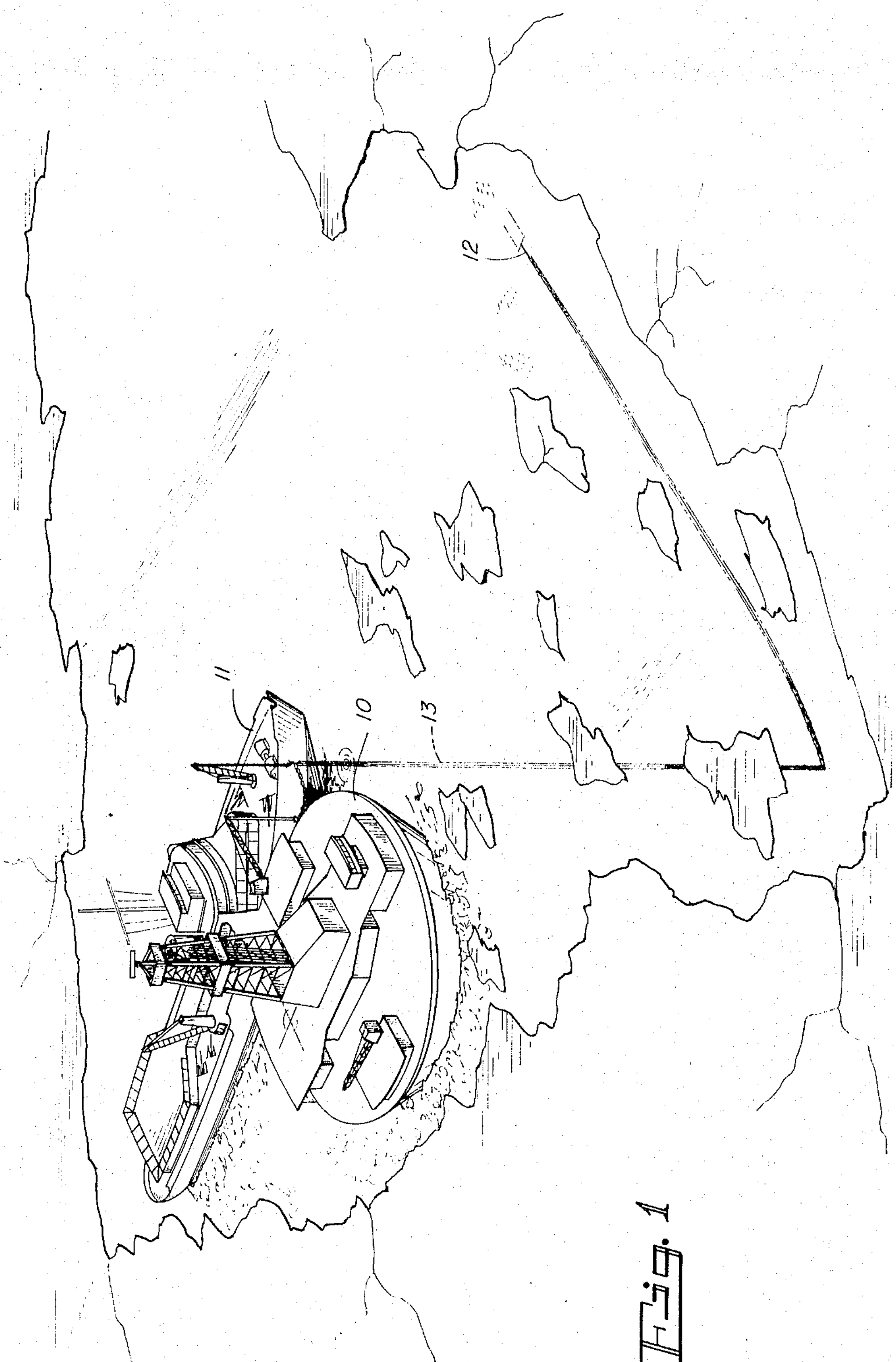


Fig. 1

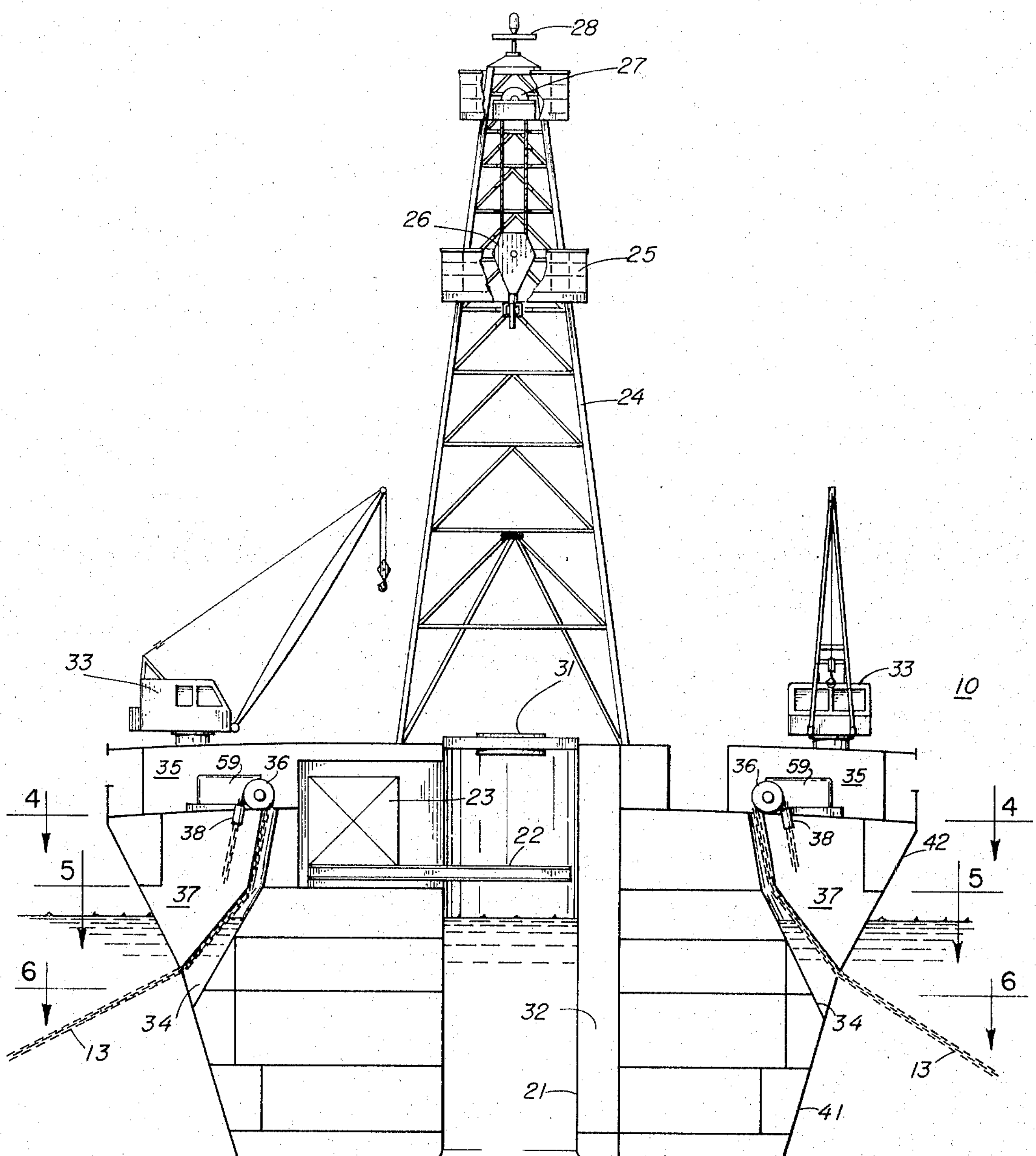

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Fig. 2

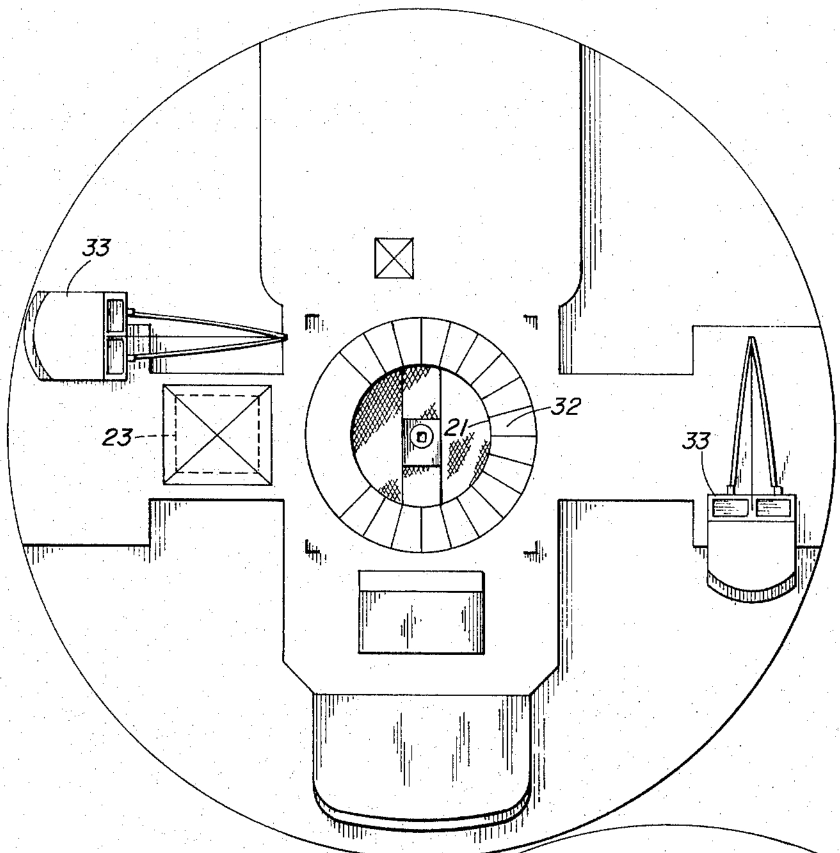

Fig. 3

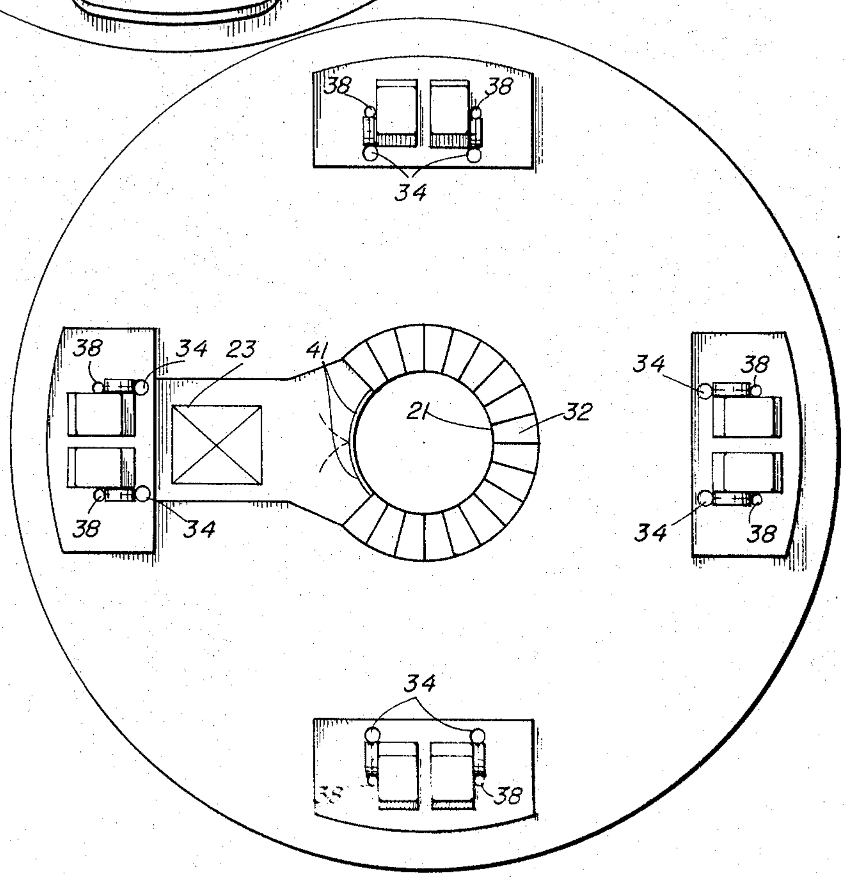

Fig. 4

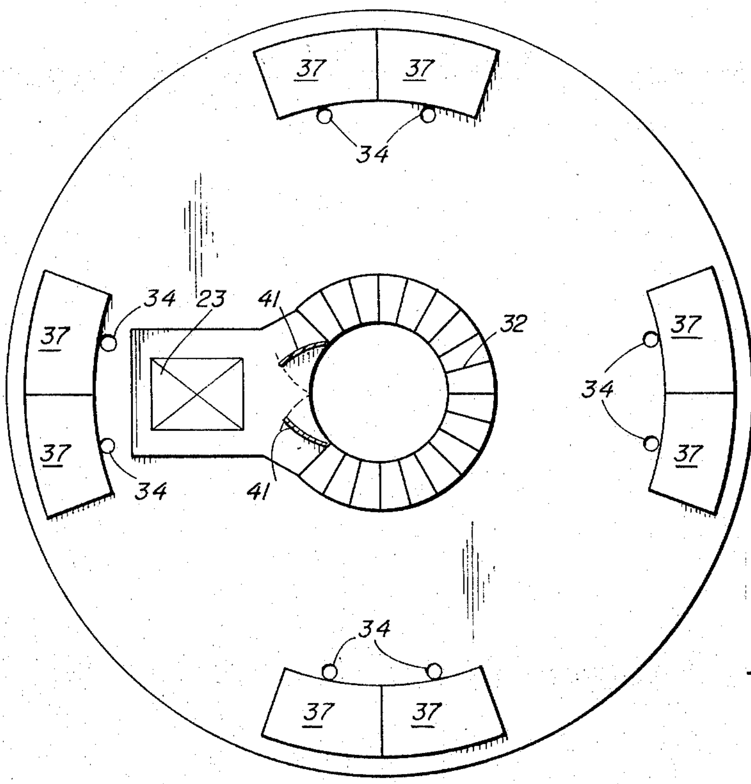
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Fig. 5

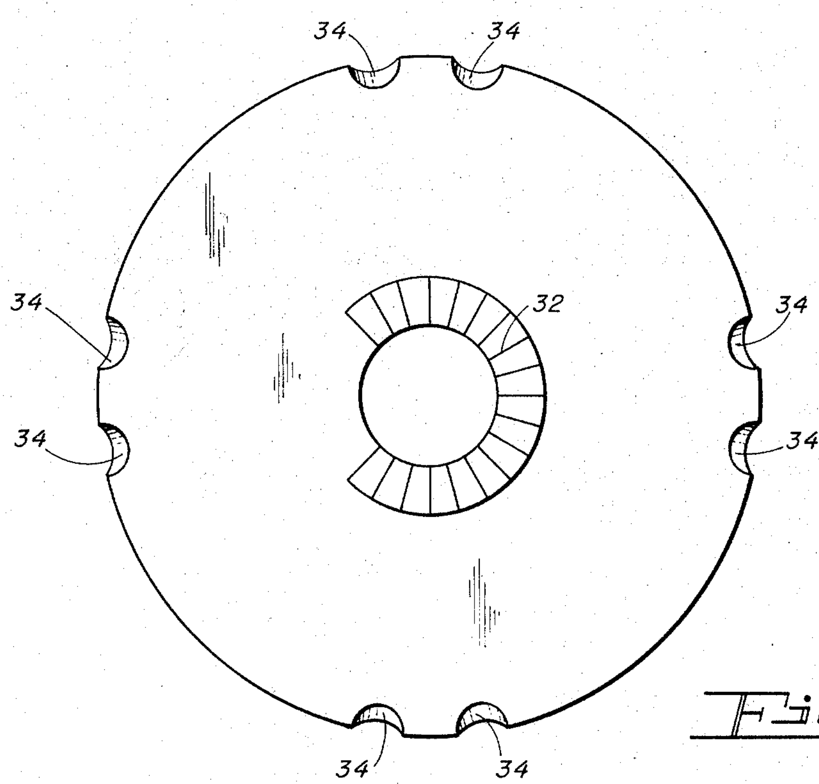
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Fig. 6

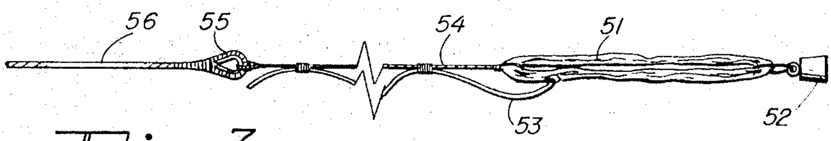

Fig. 7

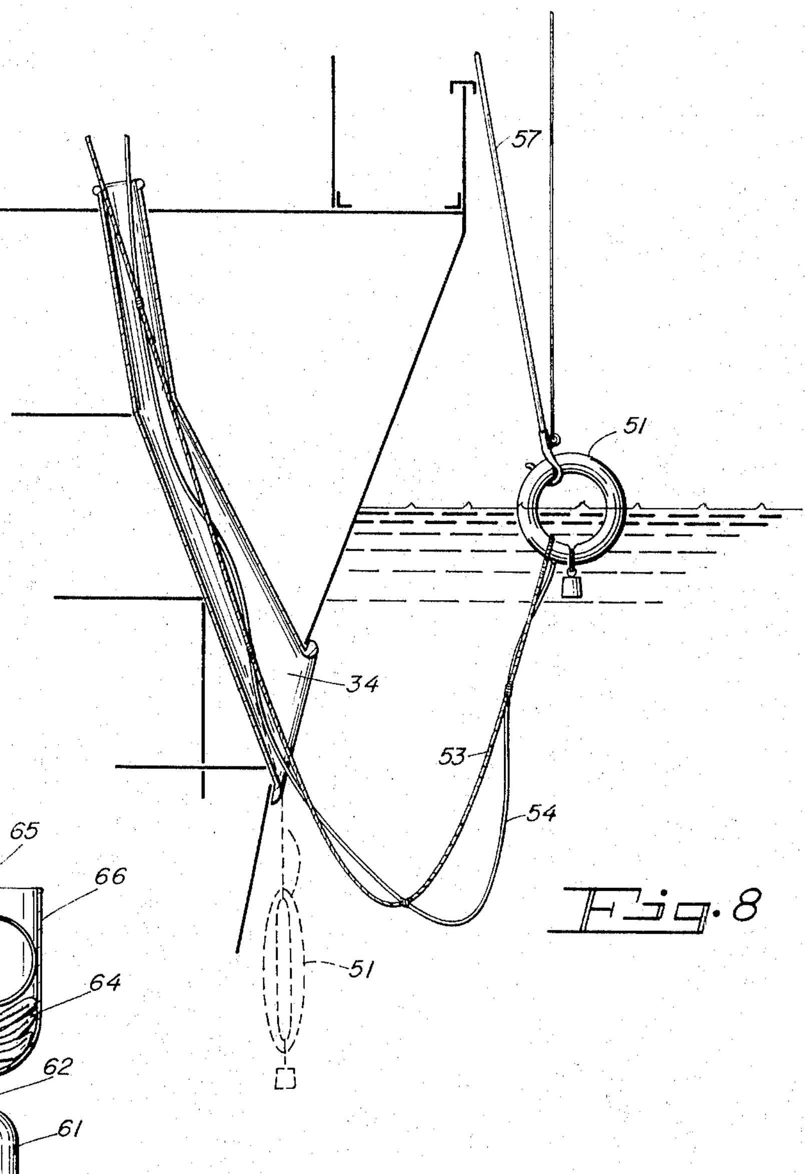

Fig. 8

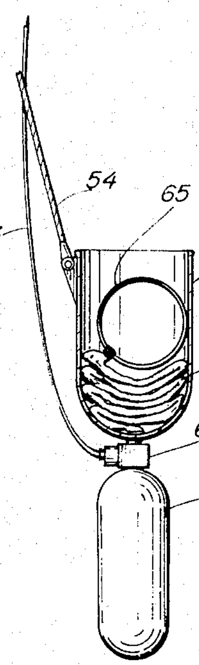

Fig. 9

MOORED BARGE FOR ARCTIC OFFSHORE OIL DRILLING

The present invention is concerned with oil drilling in offshore areas which are normally covered over by ice and in particular with a barge capable of withstanding the destructive forces of the ice, and barge mooring system which extends the station keeping ability in heavy moving ice concentrations.

Offshore drilling, until comparatively recently, was conducted almost exclusively in warm climates such as California, Gulf of Mexico, and the Arabian countries. Oil drilling rigs have long been in existence which were capable of maneuvering a drill and pipe from the surface of the water down to the sea bottom and drilling from there down to the place where oil may be found. So long as the environment which the rig was exposed to was no more hostile than sea waves, the structure of the rig could be constructed from any one of a number of suitable types for comparatively shallow areas. A rig which actually sat on the bottom and extended above the surface of the water was useful. For deeper depth, a floating rig moored in place by conventional means was useful and needed only to be made less sensitive to and resistant against the forces of waves.

More recently oil has been discovered in extremely inhospitable areas of the far north such as Alaska and Northern Canada where the offshore area is covered with up to several feet of ice for most of the year. Even when the ice has broken up in the short summer season, there are floating ice formations and other aspects of the environment far more hostile to an oil drilling rig than those previously experienced. For example, the ice, which may be up to twelve feet thick, is as capable of crushing the side of a conventional oil drilling rig as it is capable of crushing the side of a conventional ocean vessel. Additionally, a movement of the ice around the rig would sever any mooring system which attempted to connect the deck of the rig to the sea bottom. This means that the conventional type of oil drilling rig that sits on the bottom and extends above the surface of the sea is not acceptable and the normal floating drilling rig which is moored from the deck of the rig is equally unacceptable. More recently, at the 1970 Offshore Technology Conference, a new approach was suggested by Gerwick and Lloyd comprising a bottom sitting inverted conically shaped structure which is towed to the site and sunk in place. This relieves the problem of ice crushing to a considerable extent, but still possesses major disadvantages. It is not usable for deeper depth where a floating structure is required. In addition, the inverted conical shape means a very substantial volume of the total hull will be underwater where it is relatively less useful. Moreover, even with the conical shape, a bottom fixed structure is inherently less resistant to ice crushing than a floating structure.

The present invention solves these and other problems of the prior art by the provision of a floating conical structure in which the cone hull shape is upright, in that the points of the conic sections, if extended, would point downward, rather than upward as in the Gerwick and Lloyd proposal. In addition, the hull is composed of two frusto-conical sections of which the lower part is steeper than the upper part. The shape of the hull itself is similar to the General Dynamics design for the Arctic Drift Barge designed for the National Science Foundation. This Arctic Drift Barge, in an unmoored state, was designed to be able to drift in the Arctic ice pack without damage from ice. In the drilling structure of the present invention, a mooring system is provided for the hull at a point below the level of the ice. Means are also provided for attaching this mooring system to the hull on location. Because of the connection of the hull substantially below the ice level, the mooring system itself is not subjected to severe hazard from ice.

Accordingly, it is an object of the present invention to provide a moored drilling rig capable of withstanding ice crushing loads in an arctic environment.

It is further object of the invention to provide a moored drilling rig of a double frusto-conical shape to fracture ice impinging on the hull.

It is yet another object of the invention to provide a mooring system attached to the hull at a point where it will contain the hull up to a predetermined ice thickness and force without damage to the mooring system from ice crushing loads.

It is yet another object of the invention to provide a means for attaching the aforesaid mooring system to the hull on the site location.

These and other objects of the invention will become more apparent in the following description when taken together with the following drawings.

FIG. 1 shows a pictorial representation of the arctic drilling rig of the present invention with a ship in the process of mooring the hull.

FIG. 2 is a vertical cross-sectional view of the drilling rig.

FIG. 3 is a top view of the deck of the drilling rig.

FIG. 4 is a cross-sectional view of the drilling rig taken along lines 4—4 in FIG. 2.

FIG. 5 is a cross-sectional view of the drilling rig taken along lines 5—5 in FIG. 2.

FIG. 6 is a cross-sectional view of the drilling rig taken along lines 6—6 in FIG. 2.

FIG. 7 shows an inflatable device used as a portion of the system for attaching the mooring on site.

FIG. 8 is a diagrammatic representation of the device in FIG. 7 being used to moor the hull of the drilling rig.

FIG. 9 shows an alternate embodiment of an inflatable device used in the mooring system.

Referring now to FIG. 1, there is shown a drilling rig **10** with ice breaker ship **11** alongside. Ice breaker ship **11** serves the function of towing the drilling rig to the site and it is used additionally in the process of attaching the mooring system to the hull of the drilling rig **10**. An anchor **12** has been dug into the sea bottom at a distance from the drilling rig **10** by the ice breaker **11**. The anchor **12** is connected to a long chain **13** which is in the process of being handed over from the ice breaker ship **11** to the drilling rig **10**. The bitter end of the chain **13** is fed up through an opening in the hull of the drilling rig **10** in a manner which will be described subsequently.

In FIG. 2 we see the drilling rig hull **10** having a central vertical shaft opening **21** through which oil drilling pipes and drills extend to the bottom. An opening off this shaft **21** provides access for a rail system **22** along which can be slid a blowout preventer (BOP) stack which at the appropriate time can be slipped into place in the drilling operation. The construction and operation of a BOP stack are done in a manner known in the art. Extending above the drill rig over the center shaft **21** is a drill tower **24** having a monkey board **25**, traveling block and swivel 26, crown block 27 and navigation light and radar antenna 28 all of a type generally known in the art. The traveling block serves to hoist and lower drill pipe in 60 foot long sections.

At the upper surface of the deck positioned over the shaft is a rotary table 31 on which the work of connecting and inserting pipes and drills is done. A storage section 32 for the drill pipe in 60 foot sections is positioned around the center shaft. Electric cranes 33 for lifting are positioned on the top deck. As indicated in FIG. 1, these cranes may be located to the side rather than in-line with the BOP stack.

The anchor chains 13 are shown extended out in opposite directions from the side of the drill rig. The anchor chains extend through openings 34 which comprise shafts extending through the hull and up into anchor windlass areas 35 on deck. (The deck area includes both the regular surface and the outer surface of the deck housing and top deck.) Once there, they are attached to anchor windlasses 36 which haul them and hold them tight against the anchors. The bitter ends of each of the anchor chains 13 are stored in chain lockers 37, after passing through hawse pipes 38. As is shown, the sea extends up into passages 34 to the same level as it does on the outside of the ship.

As shown in FIG. 2, the outer hull shape of the hull 10 is comprised of a pair of frusto-conical forms of which the lower one 41 has a steeper angle to the vertical than the upper one 42. Passages 34 for the anchor chain exit from the hull approximately at the junction of the two frusto-conical forms, which also is approximately at the center of gravity of the hull. The surface of the sea around the hull is significantly above this junction so that even with five feet of ice on the surface of the sea and making allowances for ice being forced downward by the pressure of the hull, the chain 13 will escape contact with the ice. The upper portion 42 of the hull 10 is a broader flatter angle so that ice coming in contact with it will be bent downwardly and be fractured in the manner which has been analyzed to be performed by the Drift Barge designed as above mentioned for the National Science Foundation. The lower portion 41 of the hull 10 is more vertical in order to provide greater stability of the floating form by lowering the center of gravity and to provide more storage space. Within this below-deck storage space will be found the power plant, crew accommodations, oil tankage, water, and other necessary systems for maintenance of the rig. The bottom of the rig is provided with two retractable motors (not shown) for minor adjustment of the position of the drill hull, which are useful during the mooring operation.

In FIG. 3 is shown to better advantage the compartments 32 for the pipe sections positioned approximately three quarters of the way around the shaft 20. In FIG. 4 are shown doors 41 which close around shaft 21 except during the period when the BOP stack is passing through one way or the other. These doors prevent splashing of the sea which at this point is immediately below the floor of the storage section of the BOP stack 23. Hawse pipes 38 are shown. There are a total of eight sets of openings 34, windlass 36, hawse pipes 38, and chain lockers 37.

FIGS. 5 and 6 show the manner in which the openings 34 descend to the point of exit on the outer hull.

An inflatable ring 51 is shown in FIG. 7 attached to a small weight 52. Attached to the inflatable ring is an air hose 53 which is attached by a light messenger wire 54 to an eye 55 attached to a chain retriever wire 56. FIG. 8 shows the manner in which this device is used on site to feed the bitter end of the anchor chain 13 up through passage 34. Inflatable ring 51 descends through passageway 34 in the uninflated condition. After it has descended out of the opening 34 into the water just outside the hull the air hose attached to it fills it with air then causing it to come to the surface of the water outside of the ship. The ring 51 can then be brought up to the surface of the deck from the outside by means of a hook 57 which may be supported by the crane 33. Once the inflatable ring 51 is on deck, the air hose 53 is disconnected at the inside end and messenger wire 54 is then pulled down through the opening 34 and up the outside of the hull by pulling from the outside of the hull until eye 55 has reached the deck from the outside. The bitter end of the chain 13 which as shown in FIG. 1 has been handed over by the ice breaker is then attached to the eye 55. The inflatable ring 51 and air hose 53 are disengaged from eye 55 and the bitter end of the chain 13 is dropped back into the water. Pulling on the chain retrieval wire 56 then hauls the chain up through the passageway 34 to the anchor windlass 36. Once the anchor chain 13 is attached to the anchor windlass 36 and is being pulled over it, the chain retriever wire 56 and eye 55 are disengaged from the anchor chain 13 and it is pulled over the anchor windlass 36 and down through the hawse pipe 38 into the chain locker 37. The inflatable ring 51 may then be deflated and taken over to the next passageway 34 and the process repeated.

FIG. 9 shows an alternative embodiment of the inflatable device which brings the end of the messenger wire 54 to the surface. This device comprises a small air capsule 61 attached by a valve 62 to an inflatable bag or ring 64. Valve 62 is operated by a pull wire 63 linked to the messenger wire 54. Attached to the end of the inflatable bag or ring 64 is a solid ring 65 which when the bag 64 is inflated will be floating at the top of the device within reach of the hook. In the uninflated position, bag 64 and ring 65 are stored in a shallow open compartment 66. The embodiment of FIG. 9 may be lowered through passageway 34 as before and inflated by pulling on the pull wire 63 when it has cleared the hull of the rig by a sufficient amount to come to the surface out from the rig. It is then pulled by the hook 57. The eye 55 is fed through passageway 34 and the bitter end of the chain 13 attached to it as before, after which the chain 13 is hauled up through passageway 34 to the anchor windlass 36.

Instead of air capsule 61 being operated by a pull wire 63, it may be operated by an electrical signal, or it may be set to open in response to water pressure greater than a predetermined amount.

Reference to FIG. 1 again will disclose the process of mooring. Hull 10 is hauled by the ice breaker 11 to the desired location of the rig. Upon reaching the site the first of the anchors 12 may be dropped off the rear end of the rig and its grip on the sea bottom is pulled tight by the forward motion of the ice breaker 11. This first of the anchors 12 may be attached to the anchor windlass 36 before reaching the site, since the rear of the hull as it is towed through the ice is sufficiently shielded from ice rubbing. After the first anchor 12 is set in place and the hull 10 is holding position by means of its motors, the ice breaker 11 disengages from the hull 10 and moves out from it in a direction opposite to the first anchor **12**. The second anchor **12** is dropped and its grip on the bottom is tightened as before. The bitter end is then brought back to the hull rig and fed into the windlass **36** in the above described manner. After the first two anchors **12** are set, the position of the hull **10** is fixed. The ice breaker **11** then moves around the hull **10** setting the other six anchors **12** in turn and handing their bitter ends to the hull **10**.

By this process the hull **10** is anchored by eight chains **13** each set on the bottom and each attached to the hull **10** at a point on the hull for below water level. On a typical rig the opening of passageway **34** will be about fifteen feet below sea level, or at least ten feet below the ice even for five foot ice. Although there is leeway for 12 foot ice, as a practical matter, 5 foot ice is considered the maximum condition the hull can withstand. The position of the rig thereafter is controlled by controlling the tension on the eight anchor windlasses **36**, by appropriate hydraulic or electric motors **59**, of known type.

We claim:

1. A floating oil drilling barge comprising:

a. an upper upright frusto-conical section;

b. a lower upright frusto-conical section of a steeper angle than said upper section, said sections being joined together to form a hull having a bottom, said hull having within it a central vertical cylindrical opening in communication with the body of water in which said hull is floating; and

c. means connected to said barge for mooring it in a body of water, said means engaging the outer surface of said barge at the line of joinder of said sections.

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