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[54] **PROTECTION AGAINST SHEET ICE AT AN OFFSHORE STRUCTURE**

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[52] **U.S. Cl.** **61/1,** 61/46, 61/63

[51] **Int. Cl.** **E02b 3/00,** E02b 15/00

[58] **Field of Search** ..... 61/46, 46.5, 1, 36 A, 61/69, 63; 175/6; 299/24

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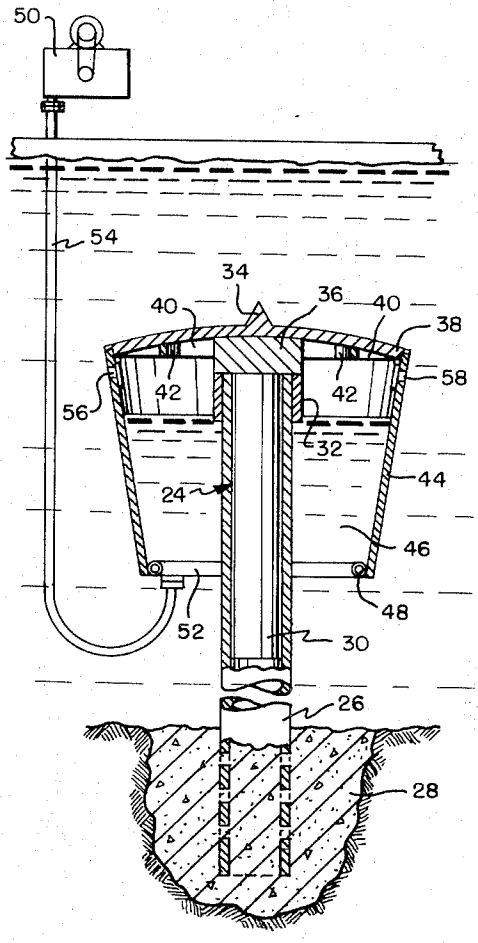
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[57] **ABSTRACT**

The invention relates to means for protecting a stationary marine platform or structure from the contingency of damage due to contact with moving sheet ice. One or more submerged sheet ice shattering members are disposed about the platform at appropriate intervals and anchored to the ocean floor. Each of said members comprises a vertically movable, fluid actuated fracturing cap. Said cap is slidably positioned on a guide pile or the like whereby to permit controlled vertical reciprocatory movement of the cap to be periodically urged into contact with the underside of an ice sheet. The resulting stress induced in the ice will cause the latter to yield and shatter into smaller, less harmful pieces.

5 Claims, 3 Drawing Figures



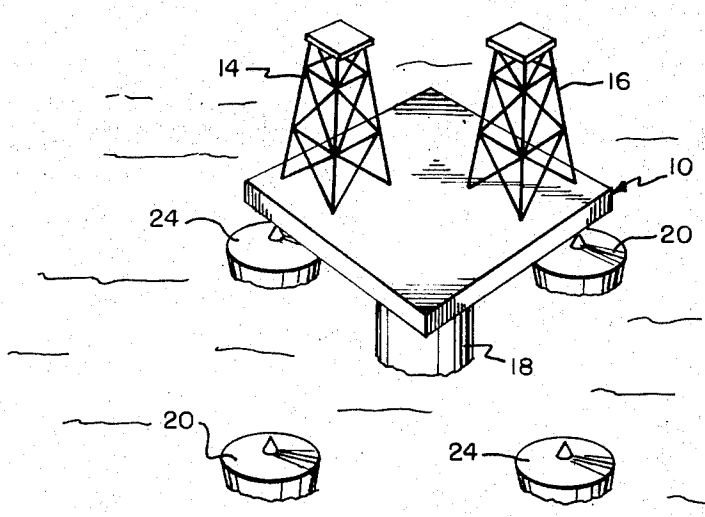


FIG. 1

FIG. 2

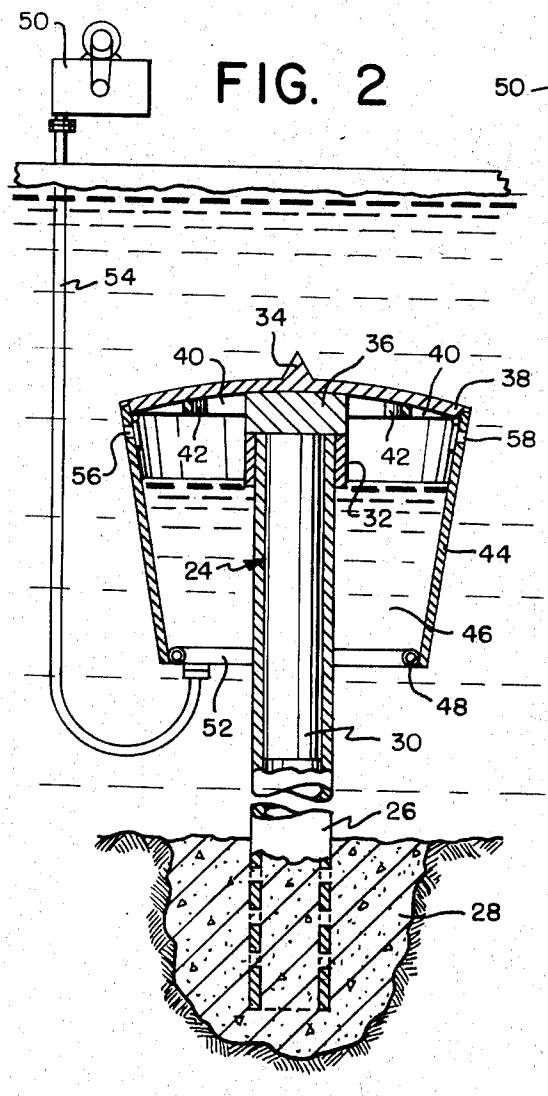
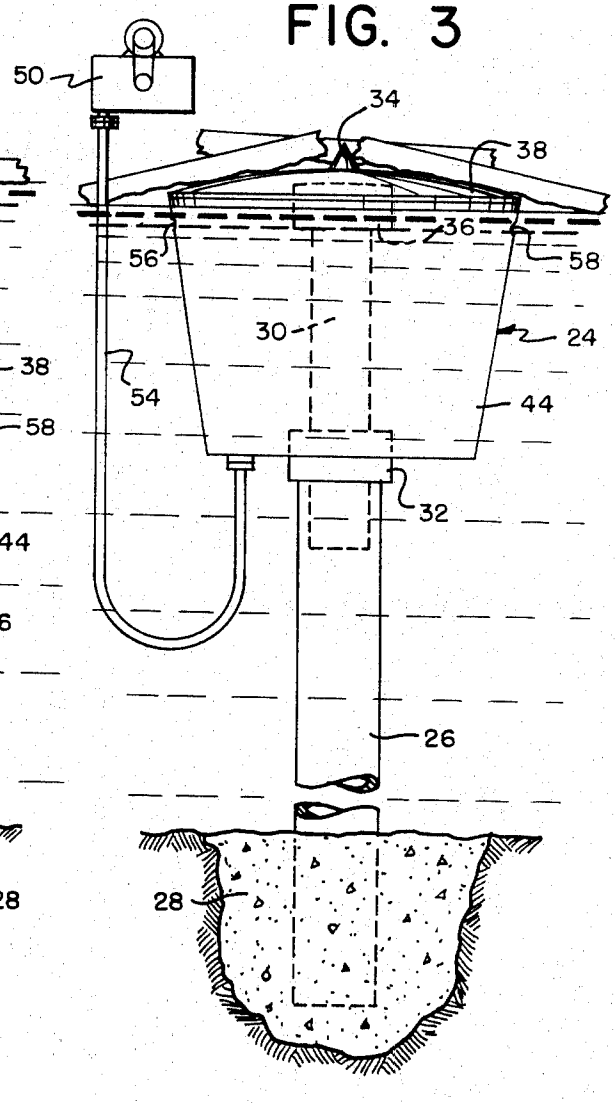


FIG. 3



PROTECTION AGAINST SHEET ICE AT AN OFFSHORE STRUCTURE

BACKGROUND OF THE INVENTION

In many parts of the world it has become desirable to drill in, and explore offshore waters for the purpose of producing oil, gas, and other usable fluids. Among the more promising areas holding these raw materials are Alaska and the Arctic section of the world. While the potential exists for producing large quantities of crude oil and gas from these locations in the future, at least one detriment to such an operation is posed by nature. Not only are the low temperatures experienced in such places as Alaska detrimental to working operations as well as equipment, but the continuous formation of ice on the water contributes greatly to the cost and economics of such production.

In essence, there exist two general categories within which the ice factor functions and must be accounted for. In the instance of large built up floes such as icebergs and the like, it is virtually impossible to fixedly place a rigid marine structure in a body of water in such manner, and of such magnitude, that it can produce oil from the substratum and yet successfully encounter moving ice masses. However, in the instance of less severe conditions where the ice problem is confined to moving floes ranging between several inches to a foot in thickness, marine platforms can be designed for use in such a body of water.

There presently exist a number of ways whereby sheet ice can be disposed of in a fashion, including contact with the platform itself thereby breaking up the ice and permitting it to pass around. One condition that gravitates against such contact is the composition of the ice which often incorporates an abrasive element as sand. In such an instance, rubbing action of the ice will function as an abrasive to wear away the support leg or legs with which the ice comes in contact.

Although marine platform support legs and similar members can be protected from damage by use of fenders, special coatings and cladding, the problem of contact with the ice nonetheless persists. Thus, a body of relatively thick ice being urged against a structure still presents a tendency toward applying a lateral displacing or overturning force.

Toward overcoming the above noted problems induced by moving ice sheets, the presently disclosed marine platform protection system is provided. Said system comprises in essence, a plurality of ice shattering units disposed discretely about a fixedly anchored marine platform, whereby to first encounter the ice prior to the latter contacting the platform. These units are embedded in the floor of the offshore site adjacent to the platform and are actuated by a pressurized fluid or gas. Thus, an ice shattering cap is periodically urged upwardly into contact with the underside of an ice sheet whereby to sufficiently stress the latter to a point where it will shatter into smaller segments. The pieces are not only rendered into a less harmful condition by virtue of their size, they also may be readily deflected away from the support leg or legs of the platform so that no contact whatsoever is made.

DESCRIPTION OF THE DRAWINGS

In the accompanying drawings,

FIG. 1 illustrates an offshore platform of the type contemplated having a plurality of ice shattering stations or units disposed there about.

FIG. 2 is a vertical elevation on an enlarged scale and in cross section, of one of the ice shattering units shown in FIG. 1.

FIG. 3 shows the device in operation.

Referring to FIG. 1, a marine structure or platform 10 is shown embedded at an offshore site, and includes a deck 12 which supports one or more upstanding derricks 14 and 16. The latter in turn support and regulate drill strings which are lowered into the substratum beneath the platform to form one or more wells. Deck 12 includes the usual equipment characteristic of such a structure, encompassing the necessary draw works, rotary table and other ancillary equipment together with storage facilities and quarters for personnel.

Deck 12 is supported by a single, column-like leg 18 disposed substantially centrally of the platform and in a vertical disposition. It should be appreciated that platforms designed to perform a similar function at offshore sites, can be provided with a plurality of such legs. However, with the increase in the number of support legs, there is a commensurable increase in the lateral displacing force exerted against the platform by ice floating at the water's surface.

Platform 10 as shown, normally positions deck 12 a sufficient distance beyond the water's surface to be out of contact with the ice or water. The lower end of column 18 extends to the floor of the body of water and is provided with a form of stabilizing base. While not presently shown, said base serves as a foundation for the platform as the latter bears against the floor of the body of water. The base is further provided with sufficient piling extending downwardly from the base and into the substratum whereby to firmly position the platform.

Normally, the offshore drilling and producing operations are disposed in tidelands where there will be a periodic fluctuation in the height of the water, depending on the local tide schedule. Thus, the water or ice flow against opposite sides of platform 10 will alternate once or twice during the day as the tide changes. It is therefore practical to arrange the instantly disclosed ice shattering units with respect to the platform so as to best encounter the ice floe as the latter will sequentially approach from opposite sides of support column 18.

Referring again to FIG. 1, the instant ice protection means comprises a plurality of ice shattering stations or units such as 20 and 22 disposed adjacent to, and spaced from platform 10 a sufficient distance to break up ice approaching the latter. In the illustrated arrangement, at least four such ice shattering stations are provided disposed at approximately 90° intervals about the structure. As a practical matter, and in certain locations a plurality of said ice shattering units can be disposed at either one, or at two opposite sides of the platform so as to best counteract the periodic movement of water and ice in response to tidal changes.

Referring to FIG. 2, one embodiment of the instantly disclosed ice shattering device or unit comprises in essence a fracture head 24 which is operably carried on an elongated guide column or pile 26. The latter is disposed in an upstanding position, being at least partially embedded at its lower end, into the substratum. Guide column 26 is sufficiently rigid to vertically support head 24 in both the latter's withdrawn and extended position, which head will in turn exert an upward force when urged into contact with a floating ice sheet. Said

guide pile **26** will further resist lateral displacement of the unit as a result of contact with the moving ice.

Guide pile or column **26,** comprises an elongated cylindrical member normally made up of a tubular steel piling material. The steel is preferably of a grade particularly adapted to withstand the low temperature characteristics of Arctic waters without undue internal stress. Either the inner or external surface of the pile wall is adapted to, or provided with means to slidably accommodate a mating surface. Said guide pile or column **26** is normally embedded vertically into the substratum by hammering, jetting or by similar means whereby to afford the pile the necessary degree of rigidity.

Pile **26** is normally embedded a desired distance in accordance with the composition of the substratum. Quite often the latter is comprised of a relatively frozen upper composition such as permafrost which is susceptible to partial thawing when subjected to variations in water temperature.

To further stabilize pile **26** within its desired seating position a foundation can be provided at the lower end thereof. Said foundation as shown can be in the form of a poured cement block, or a similarly applied cement mass adapted to both implant the pile lower end, and to rigidize the lower portion of the guide member.

Pile or guide column **26** is preferably cylindrical in configuration as mentioned, having the inner wall adapted to slidably receive a corresponding surface to sleeve **30.** The upper end of pile **26** is provided with a reinforced, peripheral steel shoulder **32** which serves to receive and support fracture cap or body **38** when the latter is in the lowered position.

Fracture head **24** comprises an elongated sleeve **30** which as noted, is slidably received on or within guide column **26.** Sleeve **30** is further provided with a central hub **36.** Disc-like body or cap **38** depends from hub **36** and radiates outwardly from a centrally positioned tip **34.** Said body or cap is contoured along its upper surface at a slightly downward slope to facilitate lifting of an ice sheet. Body or cap **38** depends from central hub **36,** being communicated through the latter to the pile **26** interior to facilitate passage of air therethrough.

While sleeve **30** is presently described as being slidable within pile or column **26,** an operable arrangement would be achieved with a similar sleeve disposed with its inner surface slidably engaging the pile outer wall. Further, while not presently shown the sleeve and pile connection is facilitated by use of circular slide bearings or rings carried in the annulus between said members.

Body **38** is of sufficient thickness and adequately reinforced by both radial and circumferential braces **40** and **42** respectively to withstand the relatively high forces imposed on said body when the latter is activated to a raised position.

The outer edge of disc-like body **38** is peripherally fastened to a casing **44** which extends downwardly therefrom in a substantially vertical, or inward direction to form a skirt and define an enclosing annular chamber **46,** which functions as a buoyancy tank. Said casing **44** in effect, together with the underside of body **38,** forms a partially enclosed, evacuable chamber **46** adapted to hold either an actuating medium or water whereby to determine the buoyancy of the shattering head. Casing **44** is open at the lower end to define an enlarged port **48** through which the water or air can be readily flowed.

For the purpose of the instant description, the actuating fluid of the ice shattering unit will be considered to be air. In actuality, said fluid can be virtually any gas suitable to be injected under pressure, into the semi-closed chamber **46** to displace water from said chamber and in effect buoy up the entire fracture head **24.** While a number of such actuating gases could be utilized to displace the water under the pressures, it will be appreciated that compressed air is utilized most economically.

Toward regulating the vertical disposition of casing **44** with respect to guide pile **26,** the casing is communicated with a source of pressurized air such as a compressor **50** or similar means. Operationally, air is selectively and rapidly introduced to chamber **46** within casing **44** by means of a manifold **52** disposed about the lower port **48.** Said manifold **52** includes a plurality of circularly arranged and upwardly directed apertures or nozzles through which air can exit and pass, when the chamber **46** is at least partially occupied by water. The source of air as noted comprising a compressor **50** or compressed gas cylinders, is communicated with manifold **52** through one or more high pressure conduits **54** which extend across the ocean floor and to the manifold inlet.

Normally the ice shattering units **20** or **22,** when in the retracted position as shown in FIG. **1,** is sufficiently depressed beneath the water's surface to permit the uninterrupted passage of a floating vessel at low tide. Thus, although a number of such ice shattering units will normally be utilized about platform **10,** their presence will cause no interference with tankers, work boats or other vessels having occasion to approach the platform.

In the process of breaking up an ice floe or ice sheet approaching platform **10,** fracture head **24** is actuated from its retracted or withdrawn position, to an extended position. Thus, a controlled stream of compressed air is introduced from source **50** by way of high pressure conduit **54,** to manifold **52,** and thence discharged into buoyancy chamber **46.** Air rising through the chamber will displace water downwardly, which, by way of the lower port **48,** will exit from said chamber. As the degree of buoyancy of fracture head **24** increases, the entire head will rise from its seated position at the upper end of guide column **26,** toward the water's surface.

The degree to which the moving member rises along the guide post **26** is dependent of course on the condition of the tide whether it be high or low. In any event, the upper end of body **38** including tip **34** will contact the undersurface of the ice. The pointed tip will function to pierce or establish a point of stress concentration in the undersurface of the ice. Thereafter, as the under pressure increases, the ice sheet will rise and shatter along the surface of body **38.**

Fracture head **24** is then returned to its lowered or retracted position by exhausting air from chamber **46.** Head **24** will then drop of its own weight. The depth to which the head is lowered is of course dependent on whether or not it is to be further used to fracture the ice. In such instance, the degree of lowering is limited, and only a minimum amount of air contained in chamber **46** is released. Thereafter, a further introduction of air will again urge the fracturing head **24** upward to re-

peat contact with another section of the ice sheet which is likewise shattered as previously noted.

The gas exhaust system incorporated within head **24** can assume a number of different embodiments suitable to achieve the disclosed function. For example in one embodiment casing **44** is provided with a plurality of valved exhaust ports **56** and **58** spaced about the casing **44** upper edge. The valves on said ports are controllably actuated to release gas from chamber **46** whereby to restore head **24** to its lowered position.

When head **24** is properly equipped discharged gas or air can of course be recirculated through a closed storage system including compressor **50.** In either instance, this step in the operation of the head will permit the desired controlled oscillatory movement of the latter.

Other modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore, only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. An ice shattering unit adapted to be stationarily submerged to the sea floor adjacent to a marine structure positioned in a body of water, the latter being subjected to periodic sheets of floating ice, which shattering unit includes;

guide means including at least one elongated cylindrical column having the lower end thereof fixedly positioned at said sea floor and extending upwardly therefrom, and having a guide surface along an inner wall thereof,

an ice shattering head operably carried on said guide surface and disposed in operable engagement therewith, being slidably movable in a vertical direction along said guide surface between extended and withdrawn positions, said shattering head being extendable upwardly a sufficient distance through said body of water to engage the underside of an ice sheet whereby to exert an upward pressure on said sheet, thereby inducing stress therein to cause the shattering of the sheet, and

means for controllably actuating said shattering head between said withdrawn and extended positions.

2. In an apparatus as defined in claim **1,** wherein said ice shattering head includes; a sleeve slidably received on said guide surface, in said elongated cylindrical column, and a disc-like member carried on the upper end of said sleeve and extending radially outward from the latter.

3. In an apparatus as defined in claim **2,** wherein said ice shattering head includes; controlled buoyancy means positioned at the underside of said disc-like member.

4. In an ice shattering unit as defined in claim **1,** wherein said disc-like shattering head includes a convex surface on the external side thereof.

5. In an ice shattering unit as defined in claim **1,** including at least one pointed tip extending upwardly from said convex surface for initially engaging the underside of an ice sheet as said head is elevated to the extended position.

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