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Galloway

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[54] **ARCTIC BARRIER FORMATION**

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[52] **U.S. Cl.** ..... **61/1 R**; 61/46

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

[58] **Field of Search** ..... 61/1 R, 46, 46.5, 4, 5, 61/52, 36 A; 14/75, 76, 21

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[57] **ABSTRACT**

A method and apparatus for the construction of multiple artificial islands (barriers) used to prevent the encroachment of pressure ridges, ice islands and sea ice upon offshore structures, marine pipelines or other marine facilities, in regions, such as arctic regions, where bodies of water are subject to freezing. Each island structure is anchored to the sea floor by piles and/or the gravity of the structure and spaced from another island a predetermined distance ranging along the seaward side of the facilities to be protected. The predetermined distance between the individual island structures depends upon the design of the facilities that are to be protected and a risk evaluation. The shorter the spacing between individual island structures the sooner the effects of grounding will occur for ice formations that move into the region in the colder seasons.

3 Claims, 4 Drawing Figures

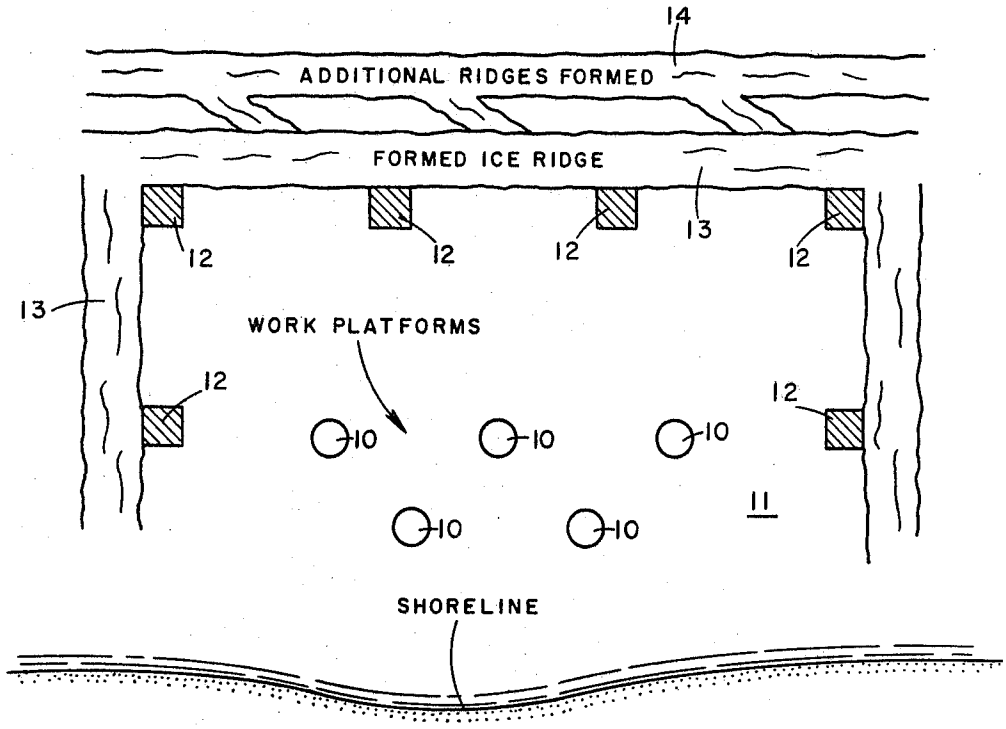
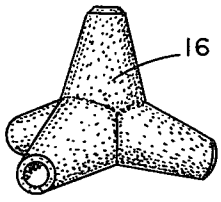


FIG. 3.



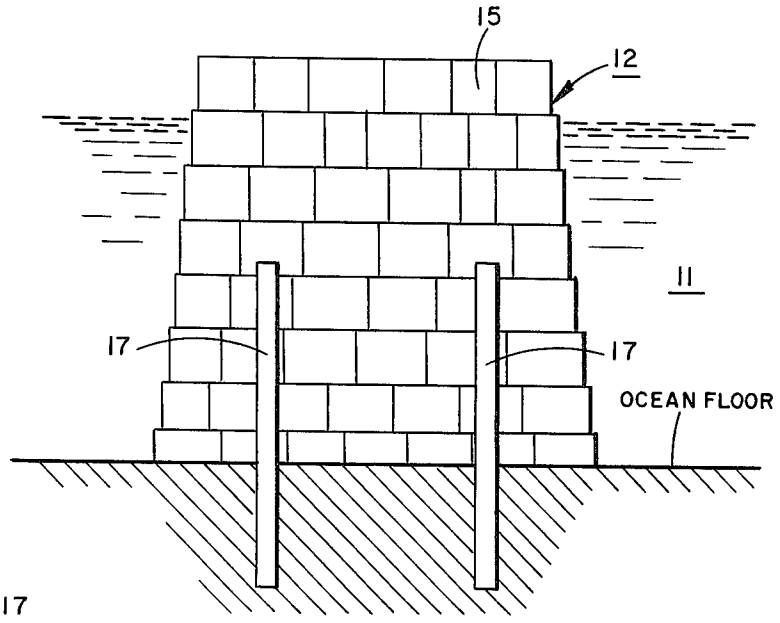


FIG. 2.

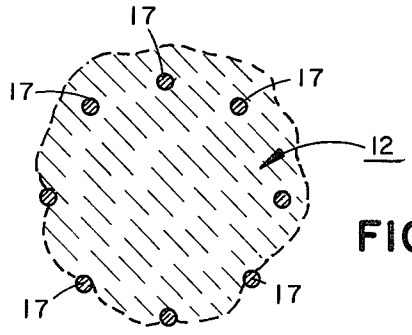


FIG. 4.

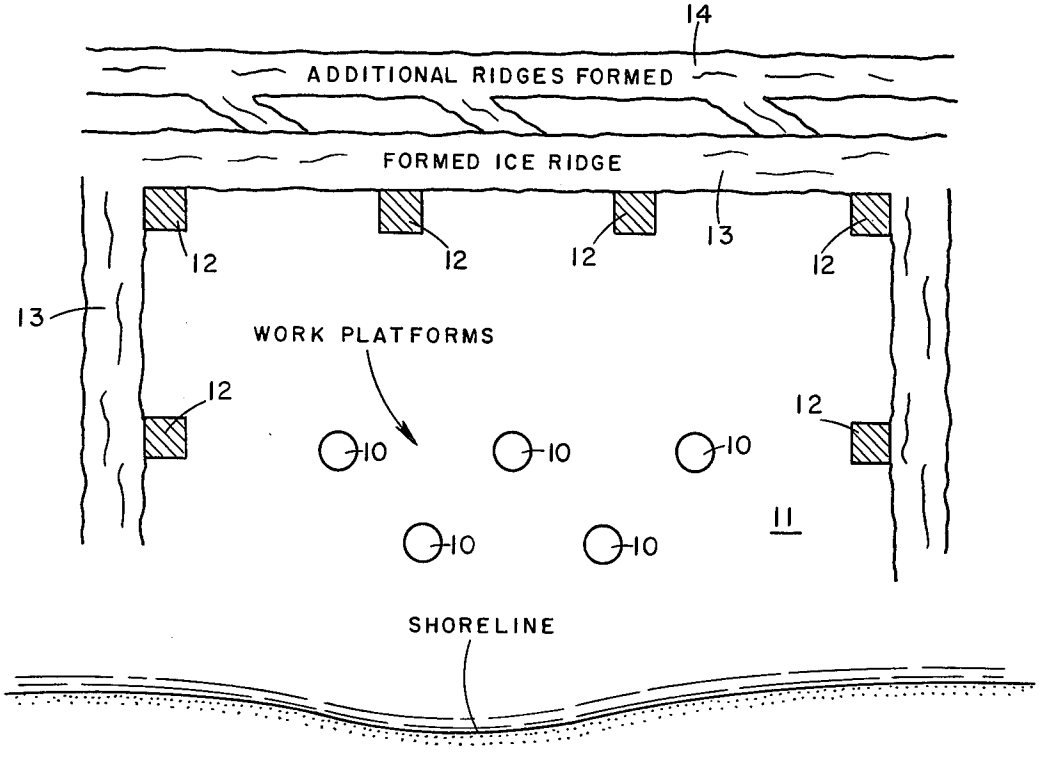


FIG. 1.

ARCTIC BARRIER FORMATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention concerns the formation of barriers in frigid, arctic regions to protect offshore facilities, such as offshore oil and/or gas production platforms, marine pipelines and other facilities.

2. Description of the Prior Art

Normally the annual ice (formed each year) freezes the frigid ocean regions (e.g., Arctic region) to a depth of from 6 to 8 feet. The total depth of the annual ice is highly dependent on the amount of snow that falls onto the ice to form an insulation blanket and prevent or retard further freezing.

The ice foot is that area adjacent to the shoreline that is shallow enough in depth to result in the water freezing through its entire depth and to the sea floor. The ice foot can also vary according to the depth of freeze each year but is normally considered to be a depth of approximately six feet. Ice that is frozen to the ice foot and is not noticeably affected by the movement of the ice pack is termed shore fast ice. In general, the shore fast ice in Canadian and Alaskan water bottoms conforms to a pattern that indicates the water depth along the seaward edge to approximately 10 fathoms or 60 feet. Although it is not a rigid rule, in general, wherever the water depth reaches 60 feet, whether it be immediately adjacent to the shore or several miles from shore, then the ice frozen to the shore terminates in what is commonly known as the shear zone. This zone is that area at the edge of the shore fast ice and beyond where the circulation of an (Arctic) ice pack causes fractures, ice pileups, ice ridges, open leads, refrozen zones and other natural phenomenon to occur.

Multi-year ice is ice that has survived the annual meltings and becomes a part of the ice pack usually in the form of pressure ridges or other ice formations caused by shearing or piling up of the ice.

Pressure ridges are ice formations caused by the shearing and rending of the ice sheets which in turn causes one portion of the sheet to break and pile up onto the other. These ridges may by quite formidable with multi-year ice forming the majority of ridges in the Arctic ice pack. Approximately one-eighth of the ridge extends above the water line and seven-eighths is below the water line. It is not uncommon to observe these ridges in areas where they have been grounded to the bottom because of depth below the water line. In some instances the strength of ice below the water line may be reduced from that above the water line because the water temperature remains about 29° F.

Ice islands are flat-topped, thick sections of multi-year ice that may have become disengaged from an ice shelf (e.g., Ellsmere Island ice shelf) and become a part of the ice pack. These ice islands become disengaged from the pack and are moved into the near shore areas. Apparently the frequency of occurrence of these ice islands varies considerably from year to year and are highly sensitive to other environmental conditions. Ice islands may vary from several hundred feet to several thousand feet in diameter.

Ice floes are generally large sheets of ice that may contain sheet ice, pressure ridges, ice islands or other ice formations that have become disengaged from the shore and are moved seaward during the warmer thaw season but may be moved into the area by winds or currents during the summer or prior to the annual freeze-up. These ice floes may be from several hundred feet in diameter to several miles in diameter.

In general, the shore fast ice is rather uniform with small pressure ridges occurring during early freeze-up and with temperature cracks occurring at intervals but no evidence of massive disruption appears as is associated with the shear zone areas. Some movements of these shore fast ice sheets have been recorded but little is known as to the nature of this movement. Some evidence is available that this movement may be a result of temperature changes.

The protective barrier proposed by the present invention is intended to protect any structures, pipelines, or other appurtenances erected in the arctic waters from encroachment by ice features described above. It is evident that structures required to resist the ice forces which result near and beyond the shear zone areas are prohibitive in cost if only presently known concepts are used.

Research has shown that when pressure ridges or ice islands become grounded in the shear zone they apparently provide building blocks upon which other pressure ridges are formed and result in the grounding of massive areas of ice seaward of the ridges. Where separate ridges have grounded several miles apart, the ridges thus formed are united into one mass of grounded ice and prevent further intrusions in the area. Thus, in accordance with the teachings of the present invention, a means to induce the grounding of the ice formations and to create a trigger mechanism to form a massive grounded formation to prevent further ice intrusion is artificially produced.

SUMMARY OF THE INVENTION

Briefly, the present invention involves forming artificial island structures offshore to protect offshore facilities by constructing on the seaward side of such facilities at least two artificial island structures, each extending from the sea floor to about sea level and secured to the sea floor. The structures are spaced apart a preselected distance to ensure formation of a protective ice barrier therebetween.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of an arrangement of artificial islands positioned to protect drilling and/or production structures upon formation of the protective barrier;

FIG. 2 is a side view showing one type island structure;

FIG. 3 is a view of a concrete tetrapod which might be used in constructing the island structure; and

FIG. 4 illustrates spacing of piles used to aid in securing the island structure blocks or other material where it is practical to pile support. In other areas it may be necessary to rely solely on gravity or the structure to resist the ice forces.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As seen in FIG. 1 there is shown a group of five oil and/or gas offshore drilling and/or production structures **10** arranged offshore in an arctic or frigid region, such as in the Arctic Ocean **11**. A multiplicity of artificial island structures **12** are arranged along the seaward edge and spaced from the drilling and/or production structures a predetermined distance. The spacing be-

tween each artificial island varies as to depth of the water. As shown in FIG. 1 an ice ridge 13 forms on the protective ice barrier which links the artificial islands 12 to each other and to the sea floor. Additional ice ridges 14 may also form behind the protective barrier.

As seen in FIG. 2, an artificial island 12 may be constructed of concrete blocks or granite rocks as shown or indicated at 15 or may be formed of concrete tetrapods 16, one of which is illustrated in FIG. 3. Spaced apart piles 17, which may vary in height as needed, are driven into the sea floor. The piles 17 provide some lateral stability for the island structure blocks and provide a base for the installation of the blocks or other material used to form the artificial island. As shown in FIG. 4, an artificial island 12 need not be confined to the space enclosed by the piles 17 and under certain conditions the structure may be installed without the aid of piles.

In areas where these bottom founded island structures are provided in relatively shallow water such protective barriers would assist in the disruption of ice floes that may be blown into the area during the warmer months and impose a threat to the offshore facilities. In applications of this nature it is proposed that these structures be placed at approximately ½ mile to 1 mile intervals along the seaward edge of the field of the facility to be protected. In deeper water the island structures are placed preferably at no more than 1 mile intervals and even closer if the island structures have not been designed to resist ice floes of the magnitude that could be blown between the protective island structures.

It is recognized that the formations of ice around the barriers, the subsequent plucking of barrier materials by the ice when it moves out, and the forces applied to the island structure barriers may result in moving or disruption of materials each year. Consequently, annual repairs may be necessary to maintain the island structures. However, it is expected that repairs will be held to a minimum if placement is made in an orderly compact manner.

Artificial islands can be constructed at various intervals depending on the water depths. The barriers formed by the artificial islands form large connected pressure ridges of sufficient size and length to prevent the encroachment of ice islands, pressure ridges, and/or sea ice on offshore facilities such as drilling and/or producing structures in the frigid ocean (Arctic Ocean-Beaufort Sea) areas. It has been proven by research that ice islands which have been grounded in water depths to 100 feet along the Arctic Ocean have provided an adequate anchor to stop movement of sea ice, pressure ridges, and ice islands shoreward. The arrested motion of these ice formations cause pressure ridges to be formed and these ridges connect laterally between these islands thus forming long arresting barriers to prevent further encroachment. With time additional ridging was observed seaward from the ridges thus formed, thereby creating a large massive protective area.

Artificial islands will also prevent large ice floes from being blown into the area during storms in warmer periods.

The island structures do not have to be designed to resist total ice floe forces but can be designed to slow the movement and cause the ice ridges and formations to produce their own resisting forces. The island placement will be made to provide the maximum amount of protection for the structures in an area or field and the spacing will be dependent upon the water depth. Another factor in the determination of the spacing will be the maximum size of ice floe which will be permitted to pass between the artificial islands during warmer ice encroachment periods.

Changes and modifications may be made in the specific illustrative embodiments of the invention shown and/or described herein without departing from the scope of the invention as defined in the appended claims.

As used herein, the term "sea level" means the surface of the water; and the phrases "near the sea level" and "to sea level" and "about sea level" used with reference to the top of the island structure all mean having the top of the island structure above, at or slightly below the surface of the water. The dimensions of the island structures will depend on the depth of the water in which they are located. In general, however, the height of the island structures will preferably be 15 feet above mean low water mark.

Having fully described the method, apparatus, objects and advantages of my invention, I claim:

1. A method for forming a protective barrier for offshore facilities in frigid regions comprising the steps of:

constructing multiple artificial islands at spaced apart distances from each other along the seaward edge of the area in which said facilities are located, each artificial island comprising materials anchored to the sea floor and extending to near sea level, spacing between each artificial island being preselected relative to the depth of water in which said island structures are located to induce grounding of ice formations such as pressure ridges and ice islands; and

creating a mass of grounded ice formations to prevent encroachment of ice formations upon said offshore facilities, said spacing being sufficiently narrow to prevent ice formations of a magnitude the offshore facilities are incapable of resisting from passing between said islands.

2. A method as recited in claim 1 in which said spacing is less than about 1 mile.

3. A method as recited in claim 1 in which said spacing is between about ½ and about 1 mile.

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