United States Patent

Bennett

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[54] **BUCKET WHEEL ICE CUTTER**

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[52] **U.S. Cl.** **61/46,** 61/1, 114/42, 299/24

[51] **Int. Cl.**.....**E02b 17/00,** B63b 35/12

[58] **Field of Search** 61/46, 46.5, 1; 299/24, 25, 299/26, 27; 37/12, 85, 83, 102, 52, 43, 45; 114/41, 42, 40

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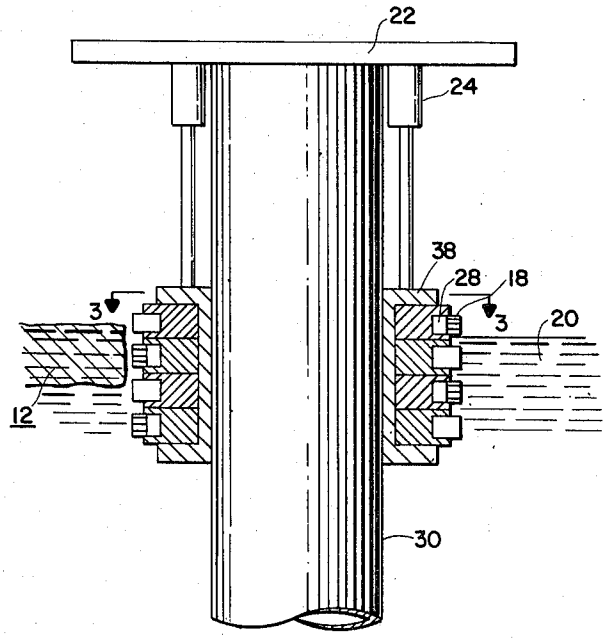
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[57] **ABSTRACT**

Bucket wheels are mounted on offshore platforms or ship prows for cutting ice sheets found in frigid waters. The bucket wheels rotate in a generally horizontal plane and are paired in opposite directions so that a torque is not placed on the structure or ship. Multiple sets of bucket wheels can be used to cut a thick section of ice and/or the bucket wheels can be inclined or arranged to oscillate up and down to cut a larger vertical section.

5 Claims, 3 Drawing Figures



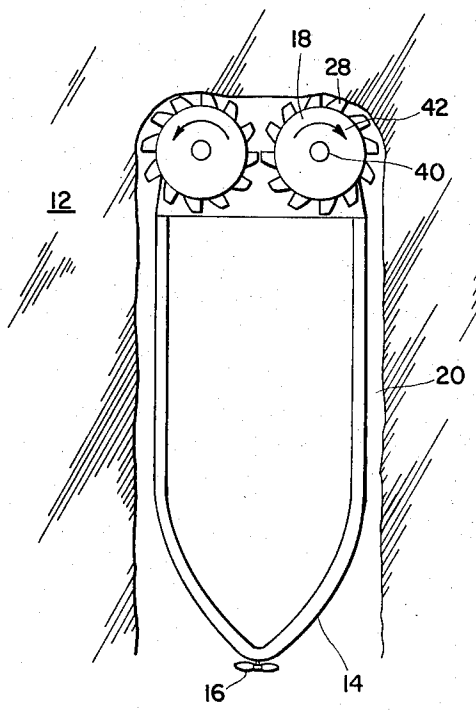


FIG. 1

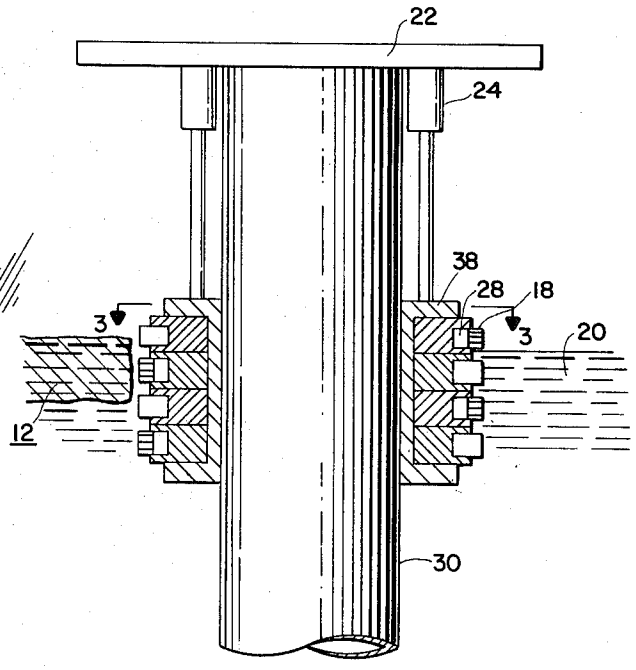


FIG. 2

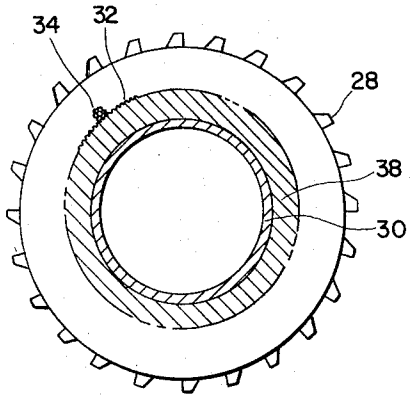


FIG. 3

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BUCKET WHEEL ICE CUTTER

BACKGROUND OF THE INVENTION

This invention deals with the problems caused by ice floating in frigid waters such as the Arctic Islands area. Currently there is high interest in exploring for and developing natural resources in such areas. In the search for and development of petroleum from offshore areas, platforms have been used which are supported on the floor of a body of water by rigid upright members. Such platforms if located in the Arctic Islands area would be exposed to ice floes which float freely in the water, and may be of such a size and propelled at such a speed that the platform support members would be subjected to damage or destruction from the severe pressures. Additionally, the specially equipped SS Manhattan recently made a voyage through the Northwest Passage to determine if a vessel could be used for transportation of hydrocarbons from areas in Alaska, and encountered difficulty in penetrating the ice. Other vessels will be attempting to serve both the offshore drilling structures and storage facilities in these areas and must be able to penetrate through the ice floes in order to reach these locations.

The Arctic Ocean adjacent the North Slope area of Alaska is typical of conditions a vessel or marine structure might encounter. This area is characterized by its shallow depth and gradual slope to deep water. Air temperatures usually range from −40° to +50° F. The water is very uniform in temperature, from +28° to +30° F., and very saline except in the lagoons opposite the rivers. Winds are predominantly from the East 10 to 15 mph, with a maximum of 50 to 60 knots, however, waves are not usually more than 5 feet high. In the months of November through April, large masses of ice are in continuous movement by the effects of wind in the Arctic Ocean. Ice fields measuring thousands of feet in diameter are propelled in many directions by the winds and are generally unaffected by the minor currents present in the Arctic Ocean.

The main ice form in the Arctic Ocean is the ice sheet, which is generally uniform and 6 to 10 feet in thickness. Another form of ice encountered is "rafted" ice, which is the term used to describe the overlapping of ice sheets as one sheet rides up over another sheet resulting in an ice floe made up of two or more distinct layers. In open locations, the rafting does not generally take place between sheets of more than 1 or 2 feet in thickness, since thick sheets cannot withstand the deflection necessary for one sheet to ride over the other. Rafted ice has a much smaller surface area than that of the more prevalent ice sheets, and is not as strong because of poor bonding between its layers.

Other forms of ice in the Arctic Ocean are the icebergs and pressure ridges. Icebergs do not occur, except in waters over 120 feet deep. Since these icebergs can be several square miles in area and can be up to 160 feet thick, in those areas where icebergs may be encountered, an above water-surface platform would not appear to be feasible. Pressure ridges occur when two sheets of ice impinge upon each other. Crushing occurs and the ice is broken and piles up above and below the general ice level. Pressure ridges may be encountered which are some 150 feet thick. These ridges should also be avoided.

Thus, it can be seen that offshore platforms located in shallow water will encounter ice sheets from 6 to 10 feet thick when located in the Arctic Ocean, and occasionally rafted or sheet ice up to 15 feet thick. Generally speaking then, an offshore platform should be able to routinely withstand at least 15 foot thick ice sheets having diameters of several thousand feet, being moved by winds of 15 mph. This ice has a shear strength of 60 psi, and a crushing strength of 300 psi. In areas other than the Arctic Ocean near the North Slope, these shear and crushing strengths have been determined to be substantially higher.

Regarding ice which a vessel will encounter while attempting to service drilling platforms located in the Arctic Ocean as well as storage facilities located in such areas as Cook Inlet and Prudhoe Bay, it is presumed that ice would not be encountered beyond the same 10 or 15 foot thick sections. It is therefore an object of the present invention to provide apparatus for aiding vessels to penetrate, and marine structures to withstand, ice floes.

SUMMARY OF THE INVENTION

With these and other objects in view, the present invention contemplates mounting bucket wheels on the prow of a vessel or on fixed marine structures. These bucket wheels are arranged to rotate in a generally horizontal plane, and when paired, are arranged to rotate in opposite directions so that torque is not applied to the structure or vessel. A series of vertically spaced bucket wheels can be used on an offshore structure, so that thicker sections of ice can be cut. Bucket wheels can be arranged to oscillate in order to cut such a larger section of ice.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section of a vessel located in an ice field;

FIG. 2 is a vertical section of an offshore platform having bucket wheels mounted thereon; and

FIG. 3 is a sectional view taken along line 2—2 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a vessel **14** motivated by propeller **16**. The vessel **14** has bucket wheels **18** located at its prow. These bucket wheels rotate on shafts **40** in the direction shown by arrows **42** and are powered by the vessel propulsion system. The bucket wheels **18** consist of a series of buckets **28** which have a leading digging edge and a bucket area for removing any dug materials. The bucket wheels **18** are depicted as rotating in opposite directions. This is to prevent torque from being applied to the vessel **14**. The bucket wheels **18** are positioned adjacent the water line and are of sufficient size to contact the full vertical height of any ice floe that they would reasonably be expected to penetrate. As propeller **16** forces the vessel **14** forward, the bucket wheels **18** contact the ice floe **12** and commence cutting into the ice floe **12**. The cut ice is moved by the buckets to the side of the vessel whereupon the ice is dumped either by gravity or a trip mechanism which is not shown. The bucket wheels **18** are positioned so that

a path is cut large enough for the remainder of the vessel **14** to pass through. It is contemplated that for operation in ice-free waters the bucket wheels would impede the speed of the vessel **14**. In such an event, it could be possible to streamline the vessel **14** by providing mechanism for re-arranging the bucket wheels, or by closing off the bucket wheel area with a movable hull member. It is also contemplated that the bucket wheels could be arranged to rotate in a vertical plane rather than in a horizontal plane as shown in FIG. **1**. Also angles between horizontal and vertical planes could be used.

Referring next to FIG. **2**, there is seen a platform **22** supported by hollow substructure **30** which is attached to the ocean floor. Mounted on substructure **30** are bucket wheels **18** which are mounted in housing **38**. Housing **38** and related bucket wheels **18** are suspended from platform **22** by hydraulic unit **24**. As depicted here, there are four sets of bucket wheels **18** which are capable of independent rotation so that two of the bucket wheels can rotate clockwise, while the other two rotate counterclockwise in order to prevent application of a torque to the platform **22** and substructure **30**. As shown here, bucket wheels **18** should have a vertical dimension larger than the height of an ice sheet **12** which can be expected to be found floating on water **20**. The vertical position of the bucket wheels **18** can be controlled by hydraulic unit **24**. If a larger than expected ice sheet is encountered, the bucket wheels **18** can be oscillated up and down so as to cut the entire sheet or the bucket wheels **18** can be positioned to cut the upper portion of the ice sheet **12**, thereby leaving only the remaining bottom portion of the ice sheet to be sheared by the substructure **30**. As shown in FIG. **2**, the bucket wheels **18** are set at an angle from horizontal so that a broader swath is cut by the bucket wheels **18**. If the bucket wheels are positioned in a plane angled from horizontal, the housing would have to be rotatable to present the most effective cutting profile to ice floes which may arrive from varied directions. Alternatively, the hydraulic unit **24** supporting the housing could be constructed to rotate relative to the platform **22** and substructure **30**. Such angular positioning also facilitates the unloading of the ice from the buckets when the cutting operation for each bucket **28** was complete.

FIG. **3** is a sectional view taken along lines **3—3** shown in FIG. **2**. Bucket wheel **18** including buckets **28** are mounted in housing **38**. Housing **38** encircles platform substructure **30**. Track **32** located on bucket wheel **18** is engaged by pinion and shaft **34** for rotation of the bucket wheel **18**. Rotation of bucket wheel **18** could also be accomplished by using the bucket wheel and platform substructure **30** as a motor. In such a situation, the platform substructure **30** would be the field, and the bucket wheel **18** would be the armature. Any other conventional means of rotating the bucket wheel **18** is also contemplated. The power source for rotating the bucket wheel **18** would preferably be a turbine or engine powered by produced fluids such as natural gas. If the marine structure utilizing the bucket wheels **18** was not a drilling and production platform having produced fuels, conventional fuels could be used. The bucket wheels contemplated herein can be the same as, or similar to ordinary digging machine wheels which are used in mining operations such as those found in mining Athabasca tar sands.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects, and therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. Apparatus for continuously cutting an ice mass located adjacent a structure in a body of water comprising: bucket wheel means including at least one pair of vertically spaced bucket wheels rotatably attached to the structure, where such attachment allows the bucket wheels to rotate in a horizontal plane.

2. The apparatus of claim **1** wherein the bucket wheel means is attached to the prow of a vessel and is of sufficient size to clear a path for the remainder of the vessel.

3. The apparatus of claim **1** including means for raising and lowering the bucket wheel means.

4. The apparatus of claim **1** wherein the bucket wheel means includes a plurality of bucket wheels vertically spaced, arranged for generally horizontal rotation, and arranged to rotate relative to each other in such a manner that no torque is applied to the structure.

5. The apparatus of claim **1** including means for rotating each of the pair of bucket wheels in opposite directions.

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