

[54] ICE CUTTING APPARATUS FOR VESSELS
OPERATING IN ICE COVERED WATERS

[75] Inventor: Joseph F. Schirtzinger, Pasadena,
Calif.

[73] Assignee: Sea-Log Corporation, Pasadena,
Calif.

[22] Filed: Apr. 8, 1974

[21] Appl. No.: 459,028

[52] U.S. Cl. 114/41; 61/46.5; 299/25

[51] Int. Cl.² B63B 35/12

[58] Field of Search 114/5 D, 40, 41, 42;
61/46.5, 1 R; 299/24, 25

[56] References Cited

UNITED STATES PATENTS

3,148,917	9/1964	Thompson	299/25
3,521,592	7/1970	Rosner et al.....	114/42
3,630,037	12/1971	Howard.....	61/1 R
3,717,115	2/1973	Abendroth.....	114/42
3,759,046	9/1973	Anders.....	114/41
3,768,428	10/1973	Schirtzinger	114/42

FOREIGN PATENTS OR APPLICATIONS

224,323 6/1968 Germany 114/40

Primary Examiner—Trygve M. Blix

Assistant Examiner—Stuart M. Goldstein

Attorney, Agent, or Firm—Christie, Parker & Hale

[57] ABSTRACT

A comminuting type rotary ice cutter that includes a vertical shaft which is rotatably supported so as to extend above and below the ice. A plurality of radial cutter arms are supported by and project from the shaft over a substantial portion of the length of the shaft, the cutter arms terminating at the outer ends in cutting edges adapted to engage and chip the surrounding ice. At least some of the cutter arms have a top surface inclined at an angle to the plane of movement of the cutter arms, the angle of incline being such that the water and chips of ice, on contacting the cutter arms, are deflected upwardly toward the top end of the shaft.

7 Claims, 4 Drawing Figures

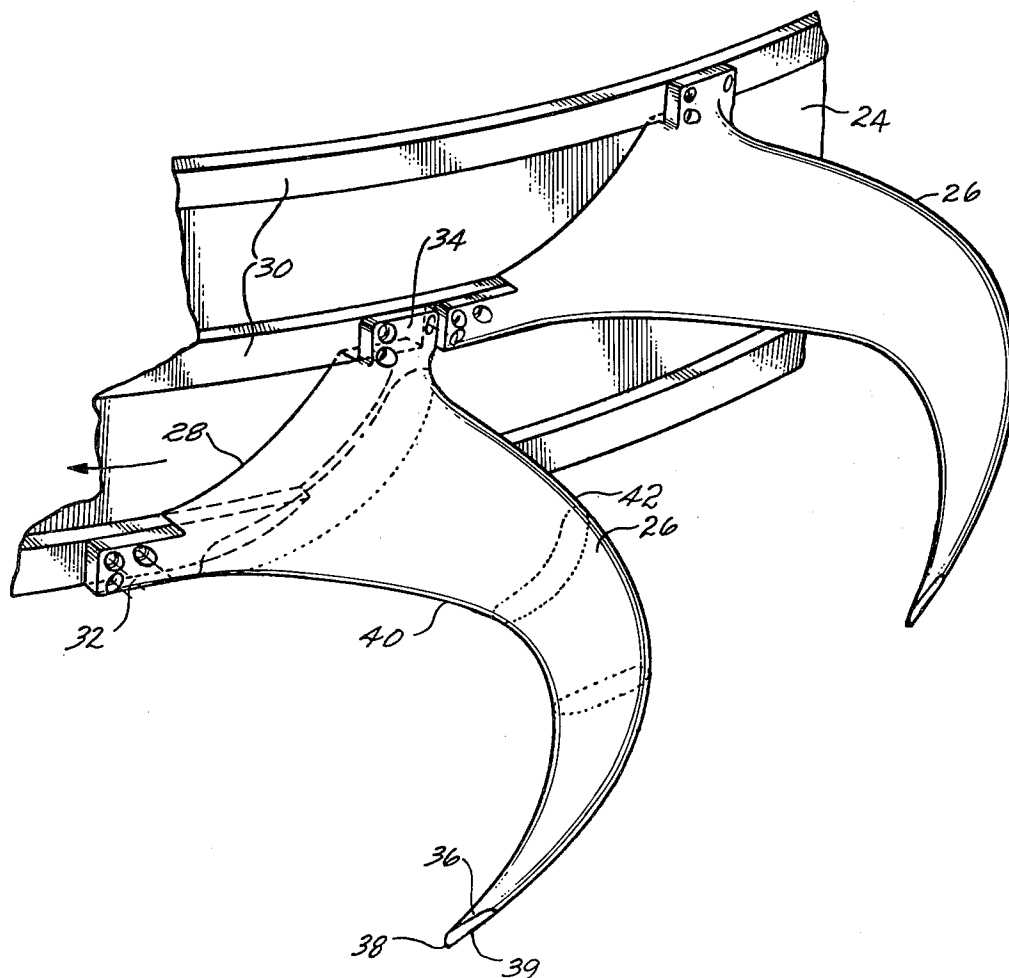


Fig. 2

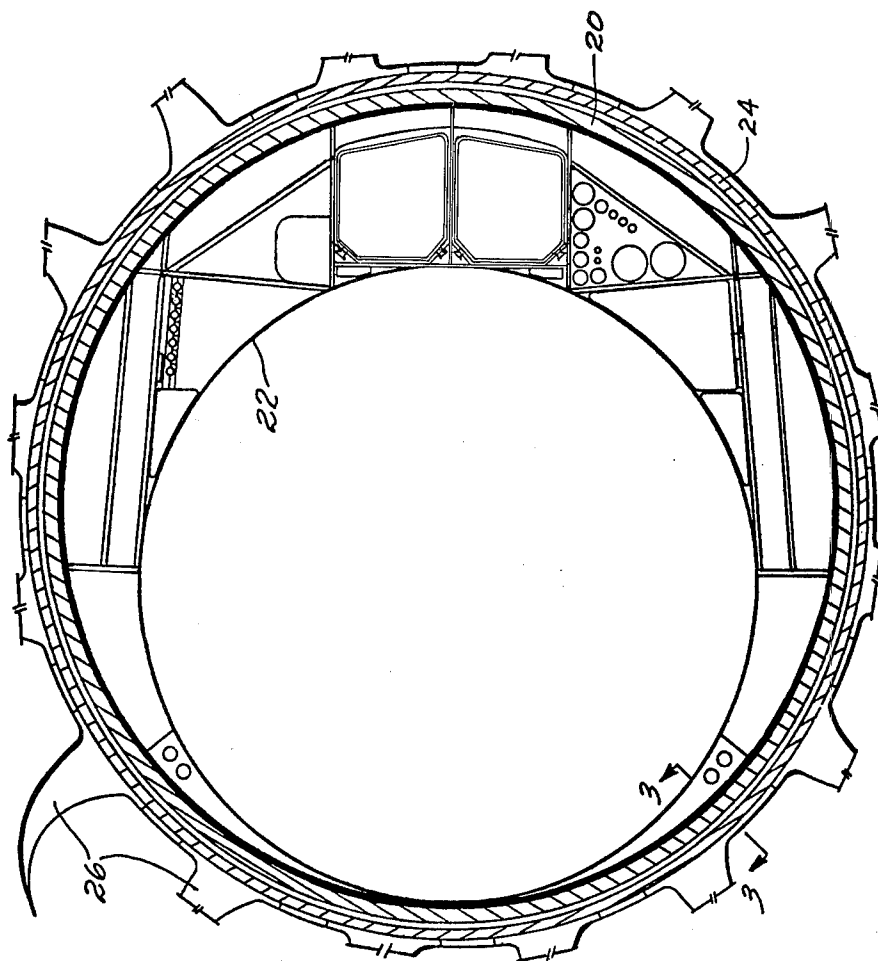
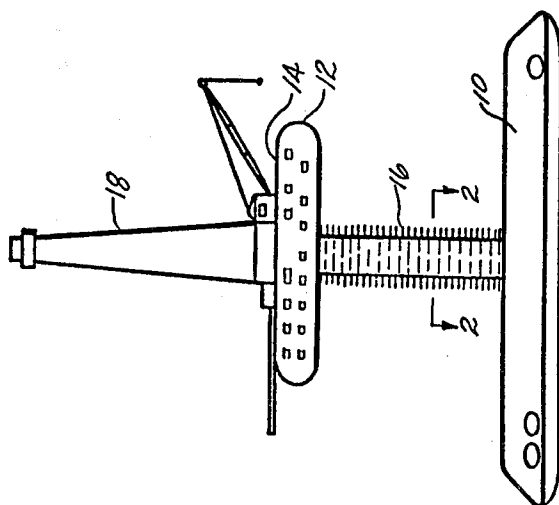
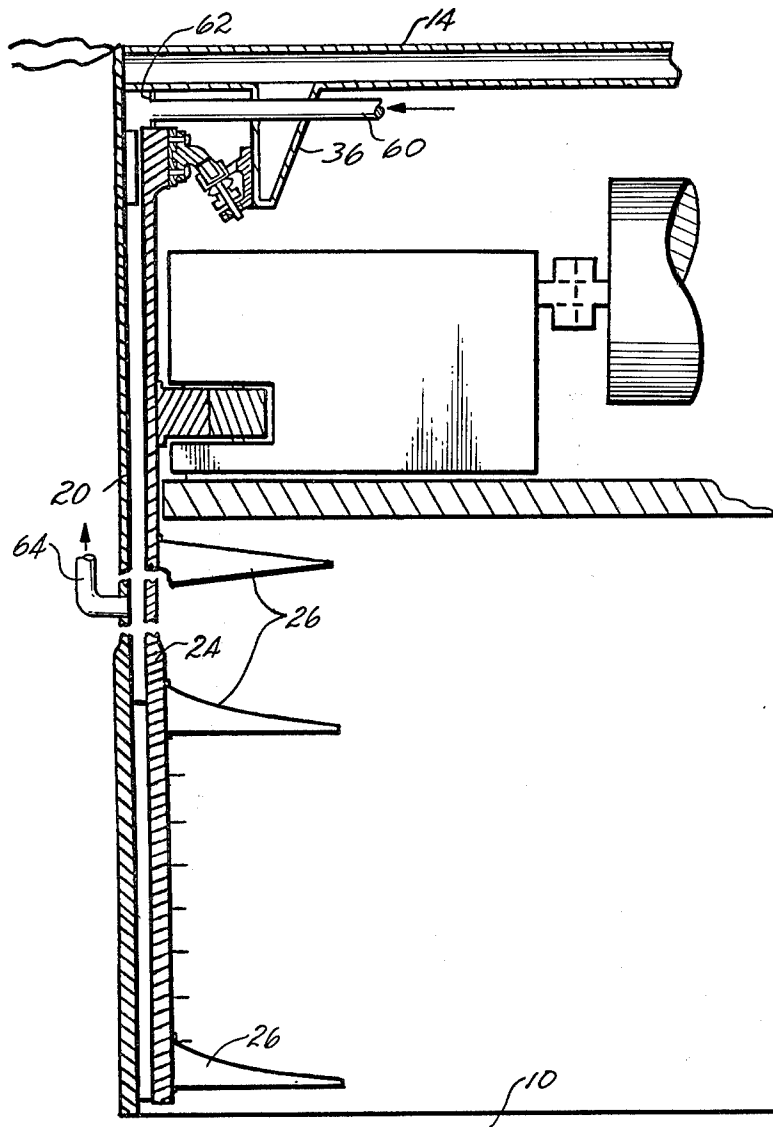
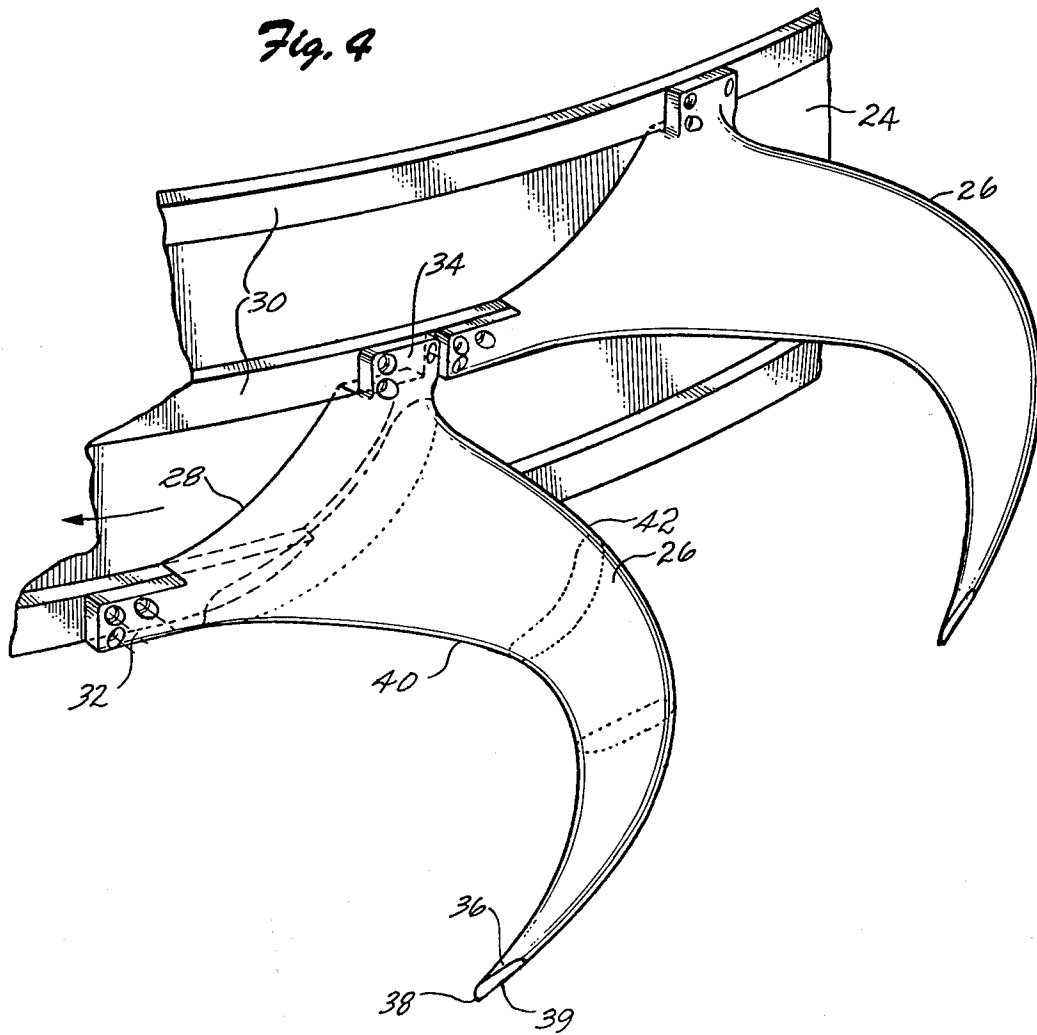


Fig. 1







ICE CUTTING APPARATUS FOR VESSELS OPERATING IN ICE COVERED WATERS

FIELD OF THE INVENTION

This invention relates to comminuting type ice cutters for vessels operating in arctic waters, and more particularly, is concerned with such a cutter having a pumping action for removing pieces of ice as they are dislodged.

BACKGROUND OF THE INVENTION

In copending application Ser. No. 459,029, filed Apr. 8, 1974, in the name of C. H. Smith, and assigned to the same assignee as the present application, there is described an ice cutter arrangement for a monopod type drilling platform. The cutter is of a comminuting type in which a plurality of radially extending cutter arms are mounted on a rotating sleeve concentrically supported on the single supporting column of the monopod structure. As the sleeve is rotated above the vertical column, the ends of the projecting arms engage the surrounding ice, cutting or chipping away ice particles from the surrounding ice sheet and permitting a path to be cut in the ice through which the supporting column of the monopod structure is able to move.

The efficiency of a cutter of this type is reduced by the clogging effect of the irregular ice chips which tend to crowd in around the cutter arms and inhibit or restrict the movement of the cutter arms. Friction between the ice chips and the surface of the cutter arms adds considerable additional drag on the movement of the arms, thus greatly increasing the load imposed on the drive source. Under very low temperature conditions, icing of the surfaces of the cutter arms and rotating sleeve further inhibit the rotational movement of the cutter assembly.

SUMMARY OF THE INVENTION

The present invention is directed to an improved cutter assembly of the comminuting type which gives greatly improved operating efficiency under all types of operating conditions. This is achieved, in brief, by providing a comminuting type rotary ice cutter in which a plurality of radial cutting arms project from a vertically supported rotating shaft and in which at least some of the cutter arms have their upper surfaces inclined at an angle to the plane of rotation of the respective arms at an angle such that water and ice impinging on the rotating arms is deflected upwardly. Thus the rotating arms produce a pumping action in which the water and ice chips produced by the cutters flow upwardly along the supporting shaft. The upward movement of the ice particles by the pumping action of the cutter arms acts to clear the ice particles out of the path of the cutter arms as they are formed. They are either deposited out onto the top of the surrounding ice or rapidly moved to the already cleared region of open water formed by the cutters. Efficiency is further improved by coating the cutter surfaces with an elastomeric material to reduce friction between the water and ice particles and the moving surfaces of the cutter assembly. Also, heated fluids are passed through the annular space between the rotating shaft of the cutter assembly and the vertical supporting column on which the cutter assembly is journaled for rotation to prevent freezing on the cutter surfaces. The downward thrust produced by the cutter arms on the supporting structure further acts to coun-

teract or oppose the lateral bending force of the support structure by the ice as it engages the cutters.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is an elevational view of a monopod drilling platform having a cutter assembly rotatably mounted on the supporting column;

FIG. 2 is a cross-sectional view taken substantially on the line 2—2 of FIG. 1;

FIG. 3 is a partial sectional view taken on the line 3—3 of FIG. 2; and

FIG. 4 is a perspective view of the individual cutter arms.

DETAILED DESCRIPTION

The base is in the form of a hull constructed of bulkheads and outer plates, providing a substantially watertight structure which may be ballasted to rest on the sea bottom at the drilling location or which may be sufficiently buoyant to float beneath the surface as a semisubmersible. A superstructure 12 providing an upper drilling deck 14 is supported above the water surface from the base 10 by a single vertical column indicated generally at 16. Drilling is accomplished from the drilling deck 4 down through the column and base into the sea floor by means of conventional drilling equipment including a drilling derrick 18 mounted on the drilling deck 14. As shown in the cross-sectional view of FIG. 2, the column consists of an outer stationary cylindrical shell 20 which is rigidly attached at its lower end to the bottom of the base 10. Inside the column 16 is a cylindrical casing 22 through which access to the ocean floor from the drilling deck is provided. The opening through the casing is referred to as the "moon pool". The casing 22 is preferably offset from the outer stationary cylinder 20 to provide a larger working space for men and equipment between the drilling deck and the subsurface base.

Surrounding the outside of the cylinder 20 and concentric therewith is a cylindrical sleeve 24. The sleeve 24 is rotatably supported and driven from the upper superstructure 12 to permit continuous rotation of the sleeve 24 around the outside of the cylinder 20. Individual cutter arms 26 are secured to the outer surface of the sleeve 24. The cutter arms are positioned around the complete circumference of the sleeve 24 and are positioned over substantially the full length of the column 16. Thus the sleeve operates as a cutter drive shaft for driving the cutters in a circular path through the water.

Details of the roller assembly are 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 application.

Referring to FIG. 4, the individual cutter arms 26 are shown in more detail. The cutter arms are forged or otherwise shaped of high-tensile strength material with a base portion 28 which rests against the outer surface of the sleeve 24. The sleeve 24 is provided with a plurality of axially spaced ribs 30. The base 28 of the arm 26 extends diagonally between two adjacent ribs. Opposite ends of the base 28 terminate in flanges 32 and 34 which are bolted or otherwise anchored to two adjacent ribs 30 of the sleeve 24.

Each arm extends radially outwardly from the base 28, the arm 26 curving in an arc so that the outer end 36 is almost tangential to the circular path of movement of the cutter tip. The end 36 is formed with a sharp cutting edge 38. The wedged shaped cutting edge 38 is formed by a flat surface 39 machined on the outer periphery of the tip 36 of the arm 26. Thus as the sleeve 24 is rotated about a vertical axis in the direction indicated by the arrow in FIG. 4, the cutting edge 38, moving at high velocity, operates to fracture and dislodge large chunks of ice from the surrounding ice sheet.

As seen in FIG. 4, the leading edge 40 of the cutter arm is substantially below the level of the trailing edge 42. In cross-section, as indicated by the dotted lines, the arm is curved upwardly between the leading edge 40 and the trailing edge 42. Thus as the arm moves through the water from right to left, as viewed in FIG. 4, the cutter arm produces a scooping action which thrusts the water upwardly as the arm moves through the water. The effect of this is to produce a strong downward thrust on the cutter sleeve 24 which in turn transmits a strong downward thrust through the roller bearing support of the sleeve 24 on the monopod structure to hold the monopod structure more firmly in place where the structure rests on the ocean bottom. At the same time, a strong upward water flow is produced which operates to force the pieces of ice, as they are dislodged by the cutters, in an upward direction, causing the ice pieces to be thrust out onto the top of the ice sheet. The net effect is to reduce the interference by the pieces of ice with the rotation of the cutters by moving the ice pieces out of the way more rapidly.

It may be desirable in some instances to design only a portion of the cutters to produce an upward thrust to the water flow. Particularly, cutters at a lower depth which are less apt to be involved in the cutting of ice except in the very thickest of ice flows, may be made with the leading and trailing edges of the arm lying in a substantial horizontal plane so as to reduce the resistance to the movement of the cutter through the water. Also, cutter arms at an intermediate depth may have a lesser pitch than cutter arms near the top to reduce resistance but still provide some upward flow.

To further reduce the drag of the cutter surfaces through the water and ice particles, it has been found desirable to coat the exposed cutter arm surfaces, with the exception of the cutting edge, with an elastomeric material, such as rubber. The coating prevents ice from building up on the surfaces of the cutter arms, particularly the arms which are at or above the surface of the water and exposed to the sometimes very low temperature arctic air.

The clogging and refreezing of ice particles either to each other or to the surfaces of the cutter arms or the supporting sleeve, can further be reduced by circulating hot fluid in the annular space between the inside of the sleeve 24 and the outside of the cylinder 20. As shown in FIG. 3, this may be accomplished by discharging engine exhaust, for example, into the annular space inside the cutter sleeve. A pipe 60 directs hot exhaust gases through an annular seal 62 into the inside of the sleeve 24. The gases are preferably directed from the annular space inside the sleeve through a pipe 64 extending up inside the cylinder 20. The pipe 64 extends through the cylinder 20 at a point above the water level to reduce back pressure on the exhaust system. Alternatively, the engine exhaust may be passed through a heat exchanger (not shown) for heating water that is pumped through the heat exchanger and the annular

space inside the cutter sleeve. Through conduction, the cutter arms are warmed sufficiently to prevent ice buildup on the cutter surfaces.

What is claimed is:

1. An ice cutter for cutting a path for a vessel through surface ice, comprising:
an elongated cutter shaft,
means rotatably supporting the shaft from the vessel, the shaft extending above and below the surface ice,
a plurality of radial ice cutter arms supported by and projecting from the shaft,
and means carried by the vessel for rotating the shaft and associated ice cutter arms about an axis of rotation, the cutter arms terminating at the outer ends thereof in cutting edges adapted to engage and chip the surrounding ice, the radial cutter arms having a leading edge and a trailing edge, the top surface of each cutter arm being inclined between the leading edge in a tangential direction, the trailing edge being higher than the leading edge as measured in a direction parallel to the axis of rotation so that the water is deflected upwardly in a direction parallel to the axis of rotation by the inclined surface.
2. Apparatus of claim 1 wherein the cutter arms are coated with an elastomeric material to reduce surface friction with the ice and water.
3. Apparatus of claim 1 further including means for heating the cutter arms to prevent icing of the cutters and shaft.
4. Apparatus of claim 1 wherein the cutter arms near the lower end of the shaft have top surfaces inclined at a lesser angle than cutter arms near the upper end of the shaft.
5. An ice cutter assembly for a monopod type drilling platform in which a single cylindrical column supports an elevated deck from a fully submerged hull, comprising a hollow cylindrical sleeve concentrically surrounding the column, means for rotatably supporting the sleeve on the column, drive means for imparting rotation to the sleeve about the axis of the column, a plurality of ice cutter arms mounted on the sleeve and projecting outwardly from the sleeve, the outer ends of the cutter arms having cutting edges adapted to cut chips of ice from any ice mass moving toward the column, and means rotated by the sleeve through the surrounding water for thrusting the water upwardly around the sleeve, the water thrusting means comprising intermediate portions of the ice cutter arms radially positioned between the sleeve and the outer ends, the intermediate portions of each cutter arm having a leading edge and a trailing edge relative to the direction of movement of the associated cutter arm as it moves through the water with rotation of the sleeve, the trailing edge being higher than the leading edge as measured in a direction parallel to the axis of revolution of the sleeve, the intermediate portion having a top surface inclined upwardly from the leading edge to the trailing edge in the direction of movement of the cutter arm through the water.
6. Apparatus of claim 5 wherein the cutter arms are coated with an elastomeric material to reduce friction between the ice and cutter arms.
7. Apparatus of claim 5 further including means circulating a heated fluid between the inside of the sleeve and supporting column to heat the cutter arms.

* * * * *