United States Patent [19]

Culbertson

[11] **3,732,918**

[45] **May 15, 1973**

[54] **BOTTOM-FREEZING APPARATUS**

[75] Inventor: **Thomas L. Culbertson,** Ventura, Calif.

[73] Assignee: **The United States of America as represented by the Secretary of the Navy,** Washington, D.C.

[22] Filed: **Mar. 11, 1971**

[21] Appl. No.: **123,312**

[52] **U.S. Cl.** .....**165/106,** 165/45, 219/326, 62/260, 61/36 A, 61/1

[51] **Int. Cl.**.....**F28d 15/00**

[58] **Field of Search**.....165/45, 105, 106, 165/137; 62/260, 351; 219/341, 326

[56] **References Cited**

UNITED STATES PATENTS

2,051,485	8/1936	Katten	219/341
2,835,480	5/1958	Perez	165/80 X
3,220,470	11/1965	Balch	165/106 X
3,472,314	10/1969	Balch	165/106
1,754,314	4/1930	Gay	165/105 X
2,893,706	7/1959	Smith	165/106

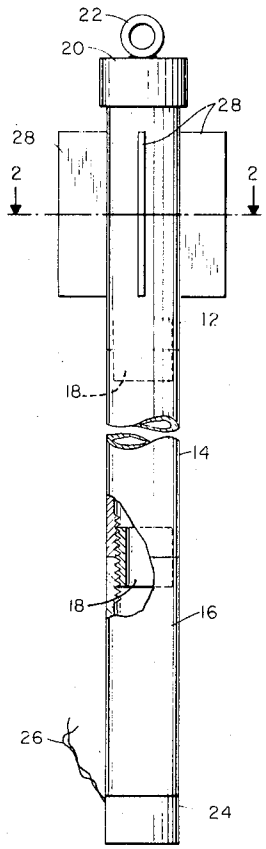
Primary Examiner—Albert W. Davis, Jr.

Attorney—Richard S. Sciascia, Q. Baxter Warner and Gayward N. Mann

[57] **ABSTRACT**

A bottom-freezing cell which operates on the liquid natural convection principle but contains no internal ducting and no insulating dividers. Additional body sections may be connected to the cell to obtain any desired cell length.

4 Claims, 2 Drawing Figures



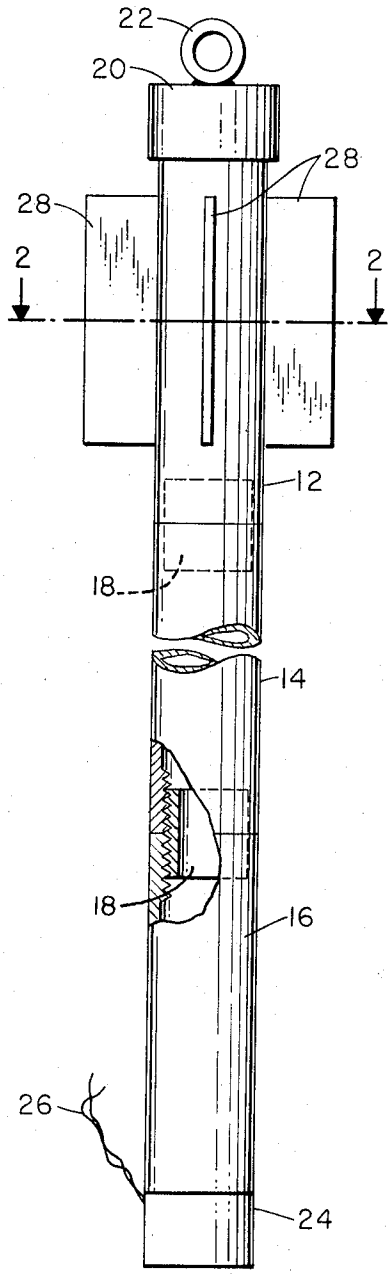


FIG. 1

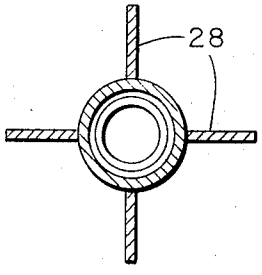


FIG. 2

THOMAS L. CULBERTSON
INVENTOR
BY Hayward M. Mann
Q. Baxter Warren
ATTORNEYS

BOTTOM-FREEZING APPARATUS

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for improving the structural characteristics of natural ice and more particularly relates to an improved bottom-freezing cell which not only improves the natural ice but accelerates the production thereof.

2. Description of the Prior Art

Due to the severe environment encountered in the polar regions, it has become a necessity to employ the naturally occurring ice materials for many constructive applications including causeways, ice wharves for handling ship cargo, vehicle ramps and shoreline foundations. Consequently, techniques and equipment are needed to thicken and improve the structural characteristics of natural sea ice to increase the operational capabilities of the area.

The prior art indicates that an accelerated bottom-freezing technique is the most effective for constructing shore or grounded ice structures. Such cells which are vertically positioned in an ice sheet and protrude into the sea water will produce ice along the entire length of the cell. Two basic convection systems have been employed in ice thickening techniques, and they are liquid convection and two-phase boiling liquid and vapor convection.

The liquid convection cell in appearance resembles generally a vertical pipe with fixed diameter and length. It is completely filled with a suitable liquid which is cooled at the top of the cell by the cold surface air, making it more dense. The cooled liquid, being heavier, would sink to the bottom of the cell where it is warmed by the heat of fusion from the outside ice formation. This warmed fluid, now less dense, rises to the top of the cell by convection and the cycle is repeated.

Two-phase convection cells are similar in appearance to the liquid convection cell. A liquid within the cell is heated by the heat of fusion in the lower part of the cell. The heated liquid vaporizes and rises to the top of the cell where it is cooled by ambient air and condenses to the liquid stage. The cycle is then repeated.

Such bottom-freezing techniques have an unquestioned value. However, they are limited in field application procedures because of their fixed size and complicated internal design. If unexpected or unknown environmental conditions should arise, the freezing cells of the prior art cannot be varied in situ to meet the necessary requirements.

SUMMARY OF THE INVENTION

Briefly, the present invention involves a bottom-freezing cell which operates on the liquid convection principle. The cell is of variable length because any number of cell sections may be connected. Moreover the cell has no internal ducting or insulating dividers. A series of fins are mounted at the top of the cell to enhance heat dissipation. A heat unit may be provided to permit facile cell removal when necessary.

STATEMENT OF THE OBJECTS OF THE INVENTION

Accordingly it is an object of the present invention to provide a relatively inexpensive bottom-freezing cell which is variable in length and contains no internal ducting or insulation.

Another object of the present invention is to provide a simple yet reliable bottom-freezing cell which operates on the natural convection principle.

Another object is to provide a bottom-freezing cell which can be adjusted to meet variable field conditions.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of the invention partially cutaway to show the interconnected sections by which the length may be varied.

FIG. 2 is a horizontal cross-section taken along the lines 2—2 of FIG. 1

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, the invention includes generally a hollow elongated cell **10** substantially filled with a liquid **26** used in the liquid convection method of heat extraction. The cell comprises an upper section **12,** a middle section **14** and a bottom section **16** which may be interconnected by threaded internal couplings **18.** In the embodiment shown the upper section **12** has four fins **28** equally spaced about the periphery thereof. The fins aid in rapidly dissipating the heat carried by the contained liquid during the convection cycle. Any desired cell length may be obtained, depending on the variable field conditions encountered, by interconnecting a sufficient number of middle sections **14** and then connecting the upper section **12** and the bottom section **16** thereto. Moreover the cell **10** has no internal ducting or insulating dividers.

The liquid substantially fills the cell **10** and is employed in the liquid convection cycle wherein heat is extracted from the area surrounding the cell. The liquid may be any suitable non-freezing substance which is a low-viscosity and high specific heat solution. Such a solution is preferably a 50—50 mixture of methol alcohol and water having a freezing point of −40° F.

A cap **20** is removably mounted on the top of upper section **12** to provide an opening into cell **10** for replenishment of the liquid **26** therein as required or for other necessary purposes. A hook receiving eye **22** is attached to cap **20** to facilitate cell handling and a heat unit **24** may be located near the bottom section **16** to permit easy removal of the entire unit from the ice which has been formed by the cell. Such heater unit may be of any desired form. If electrical, waterproof wires **26** may be employed to energize the unit. It may also be chemical if desired and suitable means provided to initiate an exothermic chemical reaction. Also, this construction lends itself to the heating up of the bottom section by removal of cap **20** and the insertion into the hollow liquid filled interior of a suitable heating element.

Thus, in one mode of operation, the elongated cell **10** is positioned in an ice sheet with the middle section **14**

substantially embedded. The fins **28** project above the ice sheet while the bottom section **16** protrudes well into the water below the ice.

Convection of the liquid within the cell **10** occurs because the liquid is cooled within the upper section **12** by the surface air working through fins **28.** The cooled liquid, now more dense, sinks to the bottom section **16** where it is warmed by the heat of fusion from the forming ice. This warmed liquid, now less dense, rises again to the upper section **12** where the cycle is repeated. It is clear then that any heat adjacent the cell **10** will be dissipated above the level of ice and a thicker ice will result.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A refrigerator cell operating on the liquid natural convection method comprising:

a hollow elongated cylindrical cell formed of at least three detachable sections with the upper and bottom sections having closed ends;

a series of heat dissipating fins attached to and spaced about the top periphery of said upper section;

means interconnecting the sections of the cell which permits varying the length of the cell; said interconnecting means adapted to provide said cell with a smooth unobstructed outer surface from the bottom of the fins to the closed end of the bottom section;

a non-freezing liquid of low-viscosity and high specific heat substantially filling said cell;

a heater positioned in heat conducting relationship with respect to said bottom section to provide facile removal of the cell from the ice sheet;

thus convection of the fluid within said cell occurs because of the temperature differential existing between the upper and lower portions of the cell.

2. The refrigeration cell of claim **1** wherein said interconnecting means are threaded internal couplings between the sections.

3. The refrigeration cell of claim **2** wherein said heater is an electrical heater.

4. The refrigeration cell of claim **2** wherein said heater is an exothermic chemical heater.

* * * * *