

[54] **HORIZONTAL BOTTOM-FREEZING APPARATUS**

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 [51] Int. Cl. **F28d 15/00**
 [58] Field of Search. **165/105, 106, 45; 62/260, 351; 219/341**

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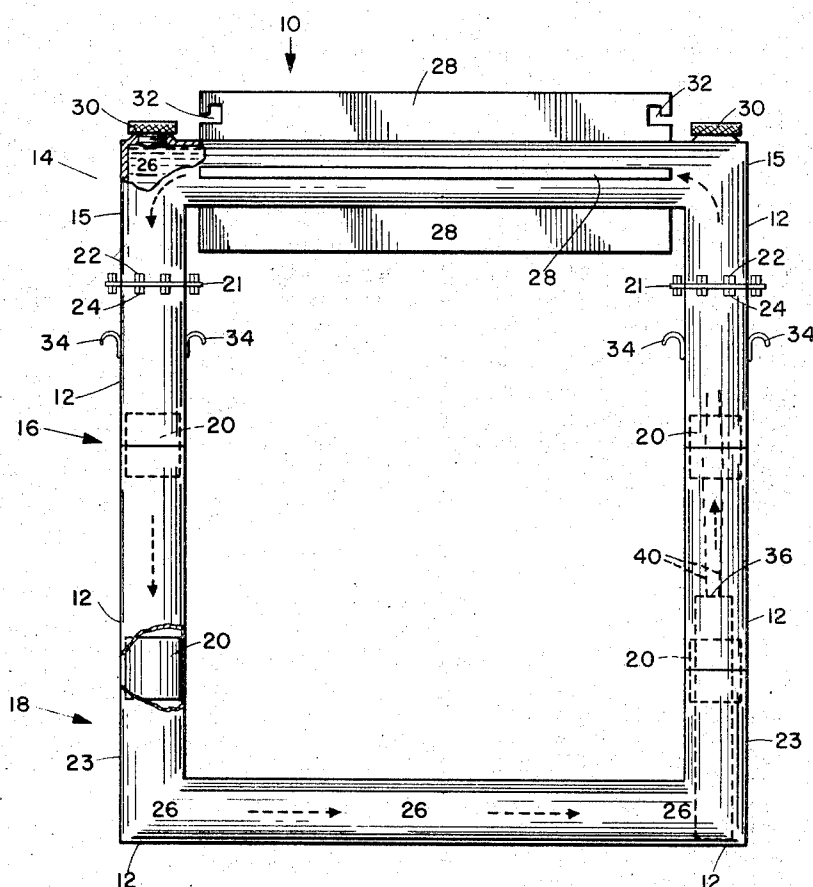
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[57] **ABSTRACT**

A horizontal bottom-freezing cell which operates on the liquid convection principle wherein loop circulation occurs because of temperature differentials between the upper and lower portion of the cell. The apparatus contains three interconnected members so that the lower member may be left in the ice strata for reinforcement purposes. Also by being interconnected the cell length may be varied as desired.

3 Claims, 3 Drawing Figures



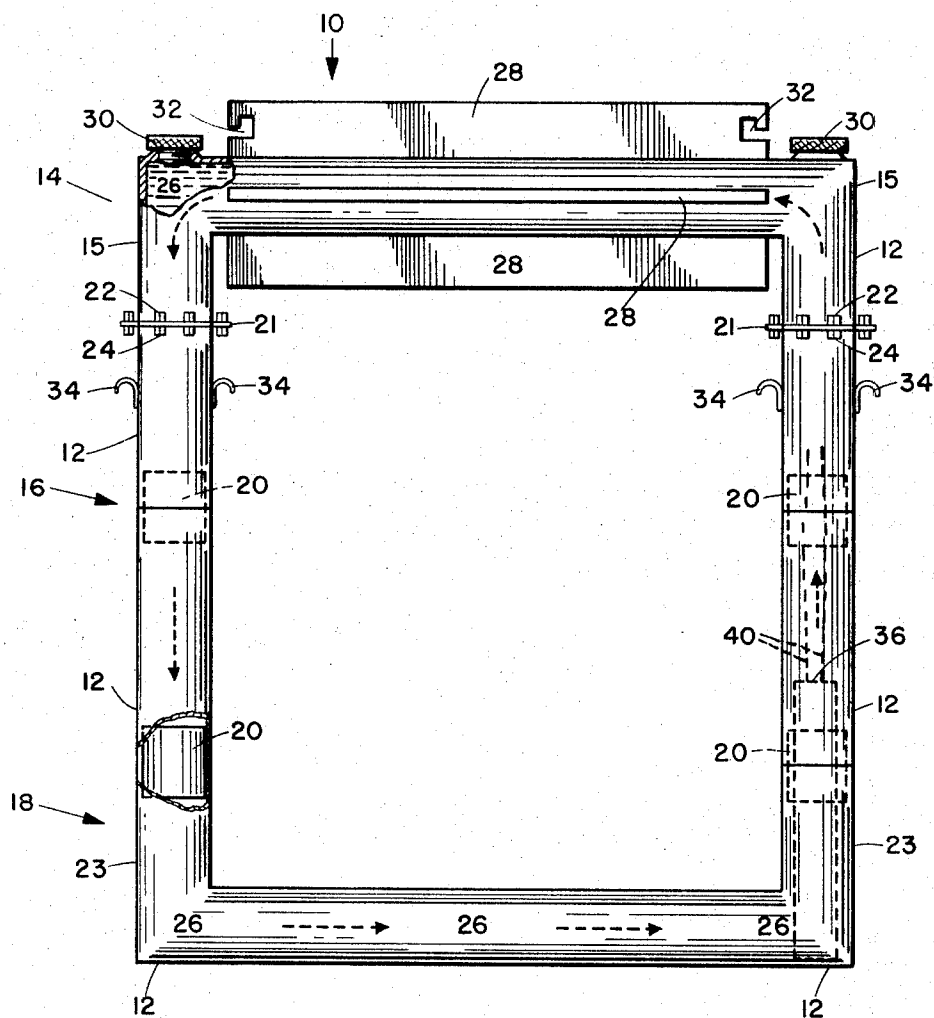
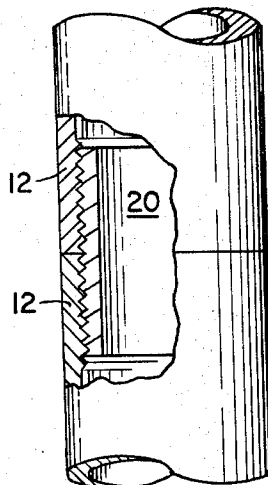


FIG. 2



HORIZONTAL BOTTOM-FREEZING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

The invention described herein is related to the invention described in application Ser. No. 123,312 filed Mar. 11, 1971, entitled "Bottom-Freezing Apparatus."

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to an apparatus which may be employed to maintain and enhance the structural characteristics of natural ice and more particularly it relates to apparatus which removes heat from the surrounding environment and transfers the same to the ambient air thus improving the capability of natural ice sheets.

2. Description of the Prior Art

In order to advance polar operational capabilities, it is 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 vertical 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, as well as complicated internal design and the vertical plane in which the ice growth occurs. If unanticipated environmental conditions should arise, the freezing cells of the prior art frequently cannot readily be varied in situ to meet the necessary requirements.

SUMMARY OF THE INVENTION

Briefly, the present invention involves a horizontally disposed bottom-freezing cell which operates on the liquid convection principle. A primary feature of this invention is the loop circulation of the cell fluid. This circulation technique provides the ability to grow ice in a horizontal plane rather than in vertical patterns. The cell is of variable length because any number of cell sections may be connected together. 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 facilitate 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 horizontally disposed bottom-freezing cell which is variable in size and contains no internal ducting or insulation.

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

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

Still another object is to provide a horizontal bottom-freezing cell having loop circulation to enhance ice formation in a horizontal plane.

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 an elevational view of the present invention with portions broken away illustrating the interconnected tube arrangement.

FIG. 2 is a top plan view of the device of FIG. 1.

FIG. 3 is an enlarged elevational view partially broken away to show the manner in which two sections may be joined together.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, the invention comprises a series of interconnected and communicating tubes 12 which form a substantially loop shaped cell 10. A liquid 26 fills the cell and is used in the liquid convection method of heat extraction wherein the liquid 26 will circulate in response to a temperature differential between the upper and lower portions of the cell.

The cell 10 is divided into a middle section 16 including a pair of spaced parallel tubular members 12 connected by internal threaded couplings 20 for disconnect engagement with the tubes of upper section 14 and to the tubes of bottom section 18. Flange couplings 21 maintained in position by suitable means such as bolts and nuts 22 and 24 respectively permit a simple union of all three sections 14, 16 and 18 and accordingly prevents unnecessary coupling problems.

The bottom tubular section 18 is generally horizontal with upturned end portions 23 which are adapted for disconnect engagement through coupling 20 with tubes of middle section 16.

The upper tubular section 14 is also horizontal with down-turned end portions 15 which are adaptable for disconnect engagement through couplings 20 to the tubes of the middle section 16.

In the embodiment illustrated, the upper section 14 has a number of spaced fins 28 preferably four, two of which are shown generally horizontally disposed and two being vertically oriented. The fins aid in rapidly dissipating the heat carried by the contained liquid 26

during the convection cycle. Any desired cell size may be obtained, depending on the variable field conditions encountered, by adding a sufficient member of middle sections 16 and then connecting the upper section 14 and the bottom section 18 thereto.

The liquid 26 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 pair of caps 30 are removably mounted on the top of both sides of upper section 14 substantially as shown in FIG. 1 to provide openings into cell 10 for replenishment of the liquid 26 therein as required. Additionally, heat units 36 may be positioned in the tubes 12 on either or both sides of either the middle or bottom sections 16 and 18 respectively by utilizing the openings 30 thereby permitting easy removal of the unit from the ice which has been formed by the cell. The bottom section 18 is normally left in the horizontally formed ice strata as a reinforcement member. Such heater unit may be of any desired form. If electrical, waterproof wires 40 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 30 and the insertion into the hollow liquid filled interior of a suitable heating element.

A hook 32 may be secured to each end of the upper vertical fin 28 and a series of hoist engagement hooks 34 may be attached to the middle section 16. These hooks are adapted to be engageable with a hoist or similar device thus facilitating handling characteristics.

Thus in operation, the cell 10 is positioned upright in an ice sheet with the elongate middle section 16 and the connecting bottom section 18 substantially embedded. The fins 28 project above the ice sheet while the bottom section 18 protrudes into the water below the ice.

Loop circulation of the liquid within the cell occurs because of a temperature differential between the upper and lower portions of the cell 10. Cell liquid 26 is cooled within upper section 14 by surface air working through fins 28. The cooled and consequently more dense liquid moves down one side of middle section 16 then across bottom section 18, rises again up the opposite side of middle section 16 to upper section 14 where the cycle is repeated all of which is indicated by the arrows shown in FIG. 2. It is clear then that any heat adjacent the cell 10 will be dissipated above the level of ice and a thicker horizontal plane of ice will result in contradistinction to vertical growth patterns.

The foregoing described horizontal bottom-freezing device is contemplated to be of specific use for the formation of horizontal ice strata for formation of the McMurdo ice wharf in the Antarctic. It is also useful in improving the surface and structural characteristics of natural sea ice to advance polar operational capabilities including the improvement of floating ice sheets, the acceleration of bottom freezing techniques for enhancing the construction of grounded and near-shore ice structures such as pins, docks and causeways.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It 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 heat transfer device for promoting ice growth in a horizontal plane for use in arctic foundation structures comprising in combination:

a horizontal bottom member adapted to be buried so that its lowermost point is located where ice growth in a horizontal plane is to be promoted and comprising a tubular member having upturned end portions;

an intermediate portion for such device comprising a pair or more of upright tubular members having disconnectable coupling means engageable with the upturned end portions of the bottom member; hoist engagement means secured to said upright intermediate members to assist in vertical removal thereof after disconnection of the intermediate member from the bottom member;

and an upper member extending into an area above the surface where a horizontal frozen strata is to be produced, said upper member being tubular in nature and having downturned end portions adapted for disconnect engagement with the upper ends of the intermediate members,

said upper member also having a plurality of heat-dissipating fins radially disposed and serving to accelerate heat dissipation from the device into the atmosphere;

at least one of said fins being apertured to receive lifting hooks to assist separation of the upper member from the intermediate member when desired;

a low freezing point liquid refrigerant normally filling the space within the assembled heat transfer structure;

and means through which such refrigerant liquid may be introduced into the hollow interior of the apparatus so formed, such refrigerant serving to conduct heat from the horizontal bottom member to the finned upper member to dissipate heat conveyed thereto by convection flow from the bottom member and hence encourage formation of ice about the bottom member, said means also serving to permit introduction of a heating element inside a vertical portion of an intermediate member to facilitate freeing the disengageable coupling means thereof so that the intermediate member may be disconnected from the bottom member to leave it in situ while the remainder of the device is removed.

2. The heat transfer device as defined in claim 1 wherein:

any desired number of intermediate tubular members may be disconnectably engaged to provide a heat transfer device of required size.

3. The heat transfer device as defined in claim 1 wherein said means through which the refrigerant liquid is introduced into the hollow interior of the apparatus includes removable caps provided on both downturned end portions of the upper member.

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