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3,380,255

UNDERWATER ICE STRUCTURE AND METHOD FOR CONSTRUCTING SAME

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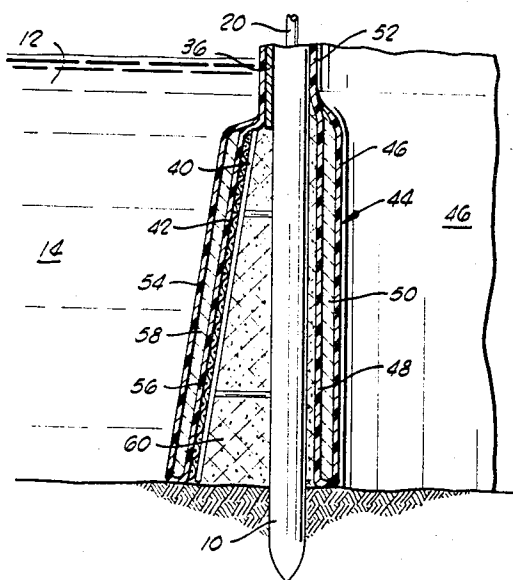
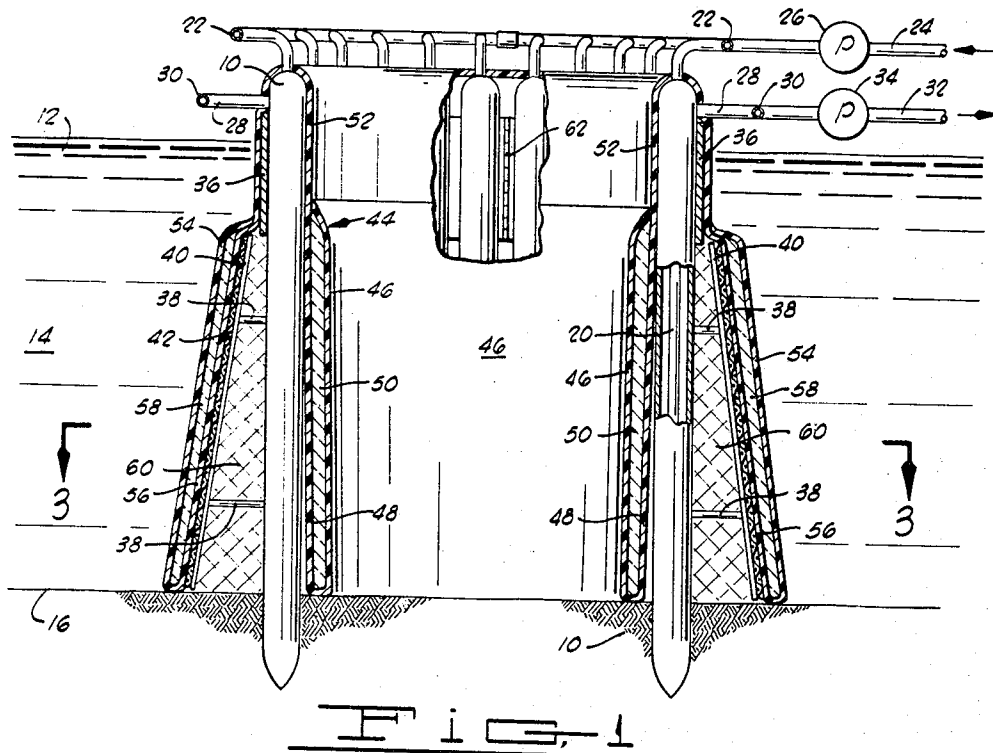


FIG. 4

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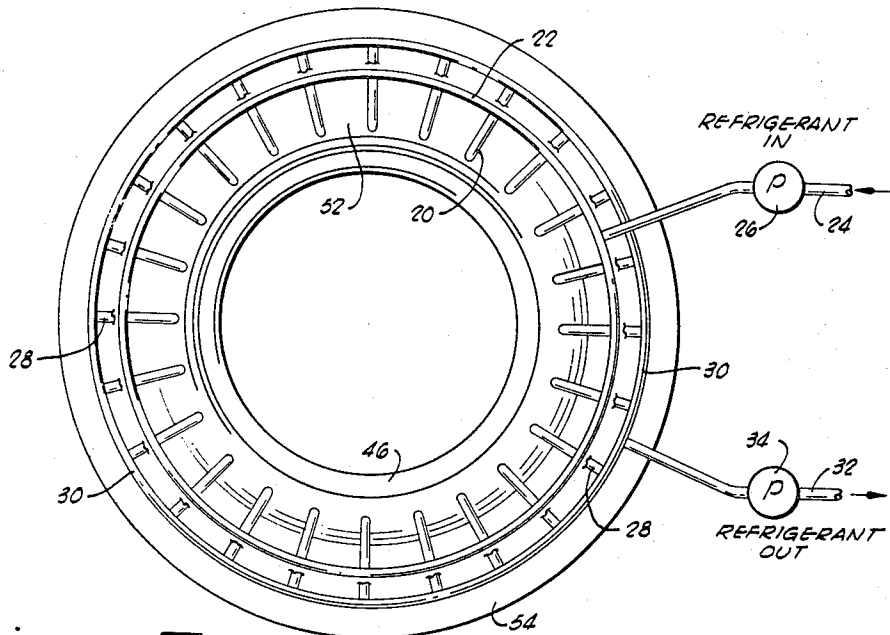


FIG. 2

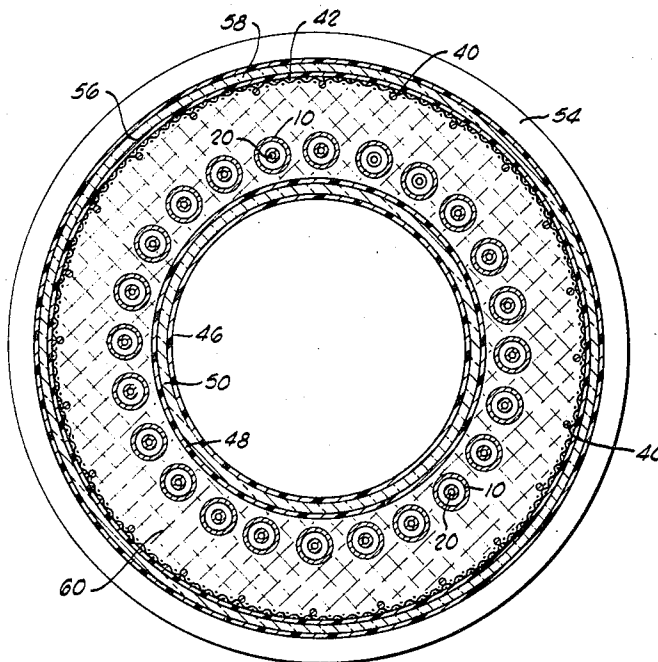


FIG. 3

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## UNDERWATER ICE STRUCTURE AND METHOD FOR CONSTRUCTING SAME

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### ABSTRACT OF THE DISCLOSURE

Apparatus and method for forming a cofferdam comprising a plurality of substantially vertical refrigerant-carrying tubes, thermal insulation along the opposite sides of the tubes and spaced therefrom to define an open space include the tubes, and a metal strip barrier at the upper ends of the tubes.

### Disclosure

This invention relates to an ice structure which is formed underwater in a desired configuration. More specifically, but not by way of limitation, the invention relates to a cofferdam constructed essentially of, and relying for its structural strength and rigidity upon, walls of ice which are formed in place at the desired location in a body of water.

Various types of cofferdam and caisson structures have heretofore been proposed, and for the most part, have contemplated the use of rigid, strong structural members made of metal or concrete. It has also been proposed to form the rigid walls of the cofferdam structure of ice. This construction has the obvious advantage of utilizing the environmental medium in which the cofferdam is to be used, i.e., water, as the primary material of construction, thus reducing the expense entailed in fabricating the structure from metal or concrete or both. In utilizing ice to form the walls of the cofferdam, it has been proposed to extend a plurality of freeze pipes from the surface to the bottom of the body of water in which the cofferdam is to be located. A refrigerating medium is circulated through the freeze pipes to convert the surrounding water to the solid state and thus form the walls of the cofferdam. It has further been proposed to provide some type of shielding means in conjunction with the freeze pipes to prevent currents, which in some instances, may be rather pronounced, from disturbing or interfering with the freezing efficiency of the pipes, or preventing the establishment of a continuous frozen wall of good watertight integrity. A structure of this general type and the manner of its use are described in United States Patent 1,495,310 to Stromborg.

Despite the proposal to construct ice cofferdams in the manner described, no widespread usage of this technique has occurred. This is believed to be due in part to the high cost of refrigerating the water surrounding the pipes carrying the refrigerant to the degree necessary to form walls of the required thickness, and to the difficulty of maintaining the integrity of such walls against the impingement of water currents. Moreover, the system which has been previously proposed presents some difficulty in installation and maintenance which detracts from the advantages of its usage.

The present invention provides an improved underwater ice structure which can be shaped as a closed ring to form a cofferdam, and which is of relatively low cost and which is more efficient in its exclusion of water from the interior of the cofferdam than generally similar ice structures previously proposed. Broadly described, the invention comprises a plurality of spaced, elongated, generally tubular members which are dimensioned to extend from the surface to the bottom of the body of water in which the ice

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structure is to be utilized, such tubular members forming freezing pipes for positioning a water-freezing heat exchange medium at the desired position under the water; and water impermeable, thermal insulation means spaced from the generally tubular members to form an enclosure shielding at least the lower portion of the tubular members, and providing a water current barrier and a thermal insulator to protect quiescent water or ice around said tubular members from the impingement of currents thereon, and to improve the heat exchange efficiency of the tubular members and the heat exchange medium contained therein.

In a preferred embodiment of the invention, the tubular members are arranged in a circular array and are grouped closely enough together so that, as the water around the tubular members freezes, a cylinder of ice is formed extending from the surface to the bottom of the body of water and provides a cofferdam structure which can be pumped out and used for the erection of permanent structures extending upwardly from the bottom. In the underwater ice structures constructed in accordance with the invention, it is further preferred to provide a metal strip adjacent the upper ends of the tubular members and extending downwardly from the surface along the members for a portion of the length thereof. The thermal insulation means can be terminated well below the surface of the water when the metal strip is utilized, since the lower edge of the metal strip can be sealed into the top of the ice wall and the water tight integrity of the structure thus made to extend all the way from the surface to the bottom. Total refrigeration costs are thus reduced and the accessibility of the interior of any volume enclosed by the ice wall, such as exists in the case of the cofferdam structure, is improved.

From the foregoing general description of the invention, it will have become apparent that an important object of the present invention is to provide an improved underwater ice structure which is stable and mechanically strong, and which can be made substantially impenetrable by the water of a flowing stream.

Another object of the invention is to provide an ice cofferdam which can be relatively inexpensively constructed and which efficiently excludes water from the interior thereof to permit permanent structures to be erected on the bottom of a body of water.

An additional object of the invention is to provide a novel apparatus which can be used for quickly forming ice structures in static or flowing bodies of water and extending from the surface to the bottom of such bodies of water.

A further object of the invention is to provide an ice cofferdam which can be less expensively constructed and maintained than generally similar structures which have been heretofore proposed.

Other objects and advantages in addition to those specifically referenced will become apparent as the following detailed description of the invention is read in conjunction with a study of the accompanying drawings which illustrate the invention.

In the drawings:

FIGURE 1 is a vertical sectional view taken substantially through the center of an ice cofferdam constructed in accordance with the invention.

FIGURE 2 is a plan view of the ice cofferdam shown in FIGURE 1.

FIGURE 3 is a sectional view taken along line 3-3 of FIGURE 1.

FIGURE 4 is a vertical sectional view of a portion of a modified embodiment of an ice cofferdam constructed in accordance with the invention, and similar in its geometric appearance to the cofferdam illustrated in FIGURE 1.

Referring now to the drawings in detail, and particularly, to FIGURE 1, a plurality of elongated tubular members 10 which function as freeze pipes are provided and are of a length sufficient to extend from the surface 12 of a body of water 14 to the earthen bottom 16 beneath the water. In the illustrated embodiment of the invention, each of the freeze pipes includes, in addition to the elongated tubular member 10, a relatively smaller diameter internal pipe 20 which is disposed concentrically in, and extends from the top to the bottom of, each tubular member. Preferably, the length of each of the tubular members 10 is such that the upper end of the tubular member extends above the surface 12 of the water for a short distance, and the lower end of each of the tubular members extends into the ground beneath the water. The lower end of each tubular member is preferably pointed to permit it to be more easily driven or forced into the earth as illustrated in FIGURE 1 and for a purpose hereinafter described.

Each of the internal pipes 20 extends through the closed upper end of its respective tubular member 10 and is connected outside the tubular member to an intake manifold pipe 22 which is used to supply a refrigerating fluid to each of the pipes 20. A refrigerant charging pipe 24 conveys a refrigerant or heat exchange medium through the intake manifold 22 and is provided with a suitable pump 26 which functions to move the refrigerant through the system in the manner hereinafter described.

A plurality of refrigerant discharge pipes 28 are connected to the upper ends of each of the tubular members 10 and communicate with the annular space between the pipes 20 and the tubular members 10, as best illustrated in FIGURE 1. Each of the refrigerant discharge pipes 28 is connected to a discharge manifold 30 which is in turn connected to a main refrigerant discharge conduit 32. A second pump 34 may be provided in addition to the pump 26 to assist in moving or circulating the refrigerant through the system as hereinafter described.

In the illustrated embodiment of the invention, the tubular members 10 and the pipes 20 which they concentrically surround are illustrated as being spaced in a generally cylindrical configuration to provide an enclosure in the nature of a cofferdam or caisson structure. It should be pointed out, however, that the tubular members 10 can be arranged in other configurations so as to form other shapes and types of underwater ice structures, and to facilitate other operations involving the damming or obstruction of water tending to move into a predetermined location.

Adjacent the upper end of the tubular members 10 and secured to the outer peripheral surface of each of the tubular members by welding or other suitable means is a generally cylindrical metal sheet or strip 36. It will be noted in referring to FIGURE 1 that the metal strip 36 is of a transverse width, and is positioned, so that a portion of the strip extends upwardly above the upper surface 12 of the water 14 for a short distance, and that the lower part of the strip extends downwardly in the water for a substantial depth which, in the illustrated construction, is approximately one-fifth the total depth of the water. The metal strip 36 is, of course, substantially impermeable to the water and functions in conjunction with ice walls formed as hereinafter described to provide a watertight, generally cylindrical barrier surrounding the tubular members 10.

Extending radially outwardly from the exterior peripheral wall of each of the tubular members 10 at points spaced below the lower edge of the metal strip 36 are a plurality of rigid brace members 38. The brace members 38 are secured at their outer ends to rigid, generally vertically extending support rods 40 which extend from a point adjacent the bottom 16 of the body of water to a point adjacent the lower edge of the metal strip 36. It will be noted that the vertically extending support rods 40 are inclined with respect to the vertical so that they converge

toward each other at their upper ends and are collectively arrayed in a generally frusto-conical configuration around the tubular members 10.

The vertically extending support rods 40 function to support a rigid insulation support means, such as a wire mesh or screen 42, a perforated plate or the like. The wire mesh 42 extends over the length of the vertically support rods 40 and completely encircles the tubular members 10 so as to form a frusto-conical enclosure.

The structure of the invention further includes thermal insulation means 44 which, in the illustrated embodiment, takes the form of a pair of sac-like chambers interconnected by an elongated flat sheet of plastic or other flexible material. One of the chambers may be termed the inner chamber, and includes a pair of parallel, spaced sheets of water impermeable material 45 and 48, such as plastic or treated fabric. The sheets are joined at their upper and lower edges to form a watertight enclosure, and the interior is filled with a relatively soft, flexible material 50 having good thermal insulating properties. An elongated flat sheet 52, which may be an extension of, or formed integrally with, the sheet 48, extends from the inner chamber of the thermal insulation means to an outer chamber which is configured similarly to the inner chamber, and which thus includes a pair of spaced, parallel sheets 54 and 56 of water impermeable material. These sheets are joined to each other at their upper and lower edges to form a watertight enclosure. A soft flexible thermal insulating material 58 of the type used to fill the inner chamber is also interposed between the sheets 54 and 56. It will be noted, in referring to the drawings, that the sheets 54 and 56 are of a generally frusto-conical configuration, and the purpose of this arrangement will be hereinafter described.

The inner sheet 56 of the outer chamber of the thermal insulation means 44 rests upon, and is supported by, the wire mesh 42. It will be noted, in referring to FIGURE 1, that the overall dimensions of the thermal insulation means 44 are such that, when the lower end of the inner chamber is rested upon or positioned adjacent the bottom 16 of the body of water 14, and the elongated sheet 52 is passed over the top of the tubular members 10 and down the outside thereof, the lower edge of the outer chamber of the thermal insulating means 44 will be positioned adjacent, or resting upon, the bottom 16 of the body of water 14. It will also be noted that the upper ends of the inner and outer chambers of the thermal insulating means 44 extends to a point in the water which is adjacent the lower edge of the metal strip 36.

#### OPERATION

In the operation of the hereinbefore described apparatus for the purpose of constructing an underwater ice cofferdam, the tubular members 10 and their associated internal pipes 20 are initially driven into the bottom 16 of the body of water 14 and are arranged in a desired configuration, such as the circular array depicted in FIGURE 1 and used in the construction of the generally cylindrical cofferdam. The connections between the internal pipes 20 and the discharge pipes 28 and their respective manifolds 22 and 30 and pumps 26 and 34 can then be made by conventional plumbing practices.

The positioning of the tubular members 10 necessarily entails the concurrent positioning of the brace members 38 and vertically extending support rods 40. These members are dimensioned and positioned so as to obtain a frusto-conical configuration in the ultimately formed ice wall. The thickness of the base of the ice wall or, stated differently, the degree to which the vertically extending support rods 40 are inclined with respect to the vertical, will depend upon the depth of the water 14 in which the structure is to be located. The deeper the water is, the thicker should be the base of the ice structure to withstand hydrostatic pressures.

After the tubular members 10 have been driven into the

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bottom 16 in the desired positions, the wire mesh 42 or other suitable rigid insulation support means is extended around, and secured to, the vertically extending support rods 40. Either prior to or after the positioning of the wire mesh 42 on the vertically extending support rods 40, the metal strip 36 is welded or otherwise suitably secured to the outer periphery of the tubular members 10, and is positioned with a portion thereof extending above the surface of the water and a portion extending downwardly into juxtaposition to the upper ends of the vertically extending support rods 40.

The final step of assembling the structure utilized to form the ice walls is that of positioning the thermal insulation means 44 on the interior and exterior of the tubular members 10 in the position illustrated in FIGURE 1. This may be accomplished in any suitable fashion, and may be performed prior to the connection of the plumbing fixtures to the tubular members 10 and the internal pipes 20 if desired. It should be noted that the thermal insulation means 44 need not be fixed or secured to any of the elements with which it is in contact, but may be merely draped in position utilizing, if necessary, suitable weights at the lower edges of the inner and outer chambers in order to anchor and retain the thermal insulation means 44 in the proper position.

With the structure assembled in the manner described, an enclosure 60 filled with water is defined between the flat sheet 48 of the inner chamber of the thermal insulation means 44, and the flat sheet 56 of the outer chamber thereof. Through this water filled enclosure extend the several tubular members 10 and their associated internal pipes 20. The water contained within the enclosure 60 is quiescent and is protected from the impingement of currents or other disturbing influences by the sheets of plastic or other water impermeable material which is used in the construction of the thermal insulation means 44.

A suitable heat exchange medium, such as Freon, liquefied nitrogen or the like, is circulated by the pumps 26 and 34 through the system to freeze the water in the chamber 60. The flow of the refrigerant is through the refrigerant charging pipe 24 to the intake manifold pipe 22 and from thence into the several internal pipes 20. At the lower ends of the internal pipes 20, the heat exchange medium moves into the annulus between the internal pipes and the tubular members 10 and flows upwardly in this annulus to leave the tubular members 10 via the discharge pipes 28, discharge manifold 30 and main refrigerant discharge conduit 32. Because of the quiescent nature of the water entrapped in the enclosure 60, and the thermal insulating properties of the thermal insulation means 44, a wall of ice is formed which extends upwardly from the bottom 16 to the lower edge of the metal strip 36. A seal is formed by the ice around the lower edge of the metal strip 36 and, since this strip extends upwardly above the surface 12 of the water 14, a completely watertight cofferdam enclosure is formed. The metal strip 36 functions to prevent ingress of the water to the interior of the structure at the top thereof, and greatly reduces the total cost of forming the structure. The reduction in cost results from the fact that it would be extremely difficult to freeze the water adjacent the surface 12 where turbulence is considerably greater than at points deeper within the water, and where the temperature of the water is generally relatively high. Moreover, use of the metal strip 36 facilitates access to the upper portion of the cofferdam.

One of the major advantages of the underwater ice structure of the present invention is the economy of construction and the ease with which the structure may be formed and re-utilized in different locations from time to time. Economy, of course, results largely from the fact that the medium in which the structure is used, i.e., water, it itself used as the main material of construction. Permanent pilings, extensive usage of metal and

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concrete, and such other conventional construction procedures are not required. Upon completion of the use of the ice structure, all of the structural elements utilized in forming the ice in situ can be easily removed from the location and re-utilized for forming underwater ice structures of the same or different configurations in other locations. Little difficulty is presented in disconnecting the piping used to convey the heat exchange medium to the structure, in removing the tubular members 10 and their associated internal pipes 20 from the ground, and in lifting the thermal insulating means 44 from its position surrounding the tubular members 10. The elements can be easily stored, transported and re-utilized at another location. It is contemplated that, in a preferred construction of the invention, the metal strip 36 will be formed as two or more hinged segments of semicircular configuration which will permit it to be more easily positioned around the tubular members 10 and removed therefrom following use of the structure. The typical location of the hinge line in this preferred construction is illustrated in FIGURE 1 and is designated by reference character 62.

It should further be pointed out that a modified embodiment of the invention contemplates the elimination of the internal pipes 20 and the intake manifold pipe 22 and charging pipe 24 associated therewith, and also the elimination of the pipes used to discharge the heat exchange medium from the tubular members 10. In such an arrangement, the tubular members 10 are open at their upper ends. To accomplish freezing of the water, the tubular members 10 are filled approximately to the level of the lower edge of the metal strip 36 with a suitable fixed heat exchange medium, such as an acetone bath containing solid carbon dioxide. By filling the tubular members 10 to the level of the lower edge of the metal strip 36 with liquid acetone and placing a substantial amount of solid carbon dioxide in the acetone, the water in the enclosure 60 can be frozen, and can be maintained in the solid state for extended periods of time by merely renewing the supply of solid carbon dioxide as it sublimates and is lost from the tubular members 10 by vaporization.

In some instances, it may be desirable to provide frozen walls in a cofferdam or other underwater structure, which walls have greater strength and higher density than the pure ice walls will alone provide. For example, where the enclosure 60 is located at a relatively great depth in the water 14, the natural buoyancy of the ice with respect to the water may be such that some method of anchoring or retaining the ice walls firmly intact with the bottom 16, other than the anchorage afforded by the driving of the tubular members 10 into the bottom, may be desirable. In this eventuality, it is contemplated that the enclosure 60 surrounding the tubular members 10 and enclosed by the thermal insulation means 44 can be preliminarily packed with sand or other aggregate or particulate material, as illustrated in FIGURE 4. The sand is then saturated with water, and the saturated sand is frozen in situ in substantially the same manner as has been described hereinbefore with respect to the water which, in most instances, will be used to occupy this space. The water in the interstices of the sand will be frozen and the frozen saturated sand will provide a dense medium which, in addition to providing the desired watertight integrity and structural strength, will possess sufficient density that it will serve to anchor the structure and retain it firmly on the bottom 16.

From the foregoing description of the invention, it will have become apparent that the invention provides an improved underwater ice structure which is versatile in its utility and can be much more economically constructed than most general purpose structures of this type as they are fabricated by conventional methods now in use. The ice structure of the invention can be quickly formed and remains stable when established due to the protective

environment provided by the novel thermal insulating means which surrounds the ice and protects it from the impingement of destructive thermal and water currents. The structural elements utilized in freezing the water in position can be recovered in substantially unchanged form after the use of the structure is completed, and can be re-utilized in other locations.

Although certain specific embodiments of the invention have been herein described in order to provide examples of the practice of the invention, the illustrated and described structures may be modified in many respects without departing from the basic principles of the invention. All such modifications and innovations which are effected in the structure without departure from such basic principles are deemed to be circumscribed by the spirit and scope of the invention except as the same may be necessarily limited by the appended claims or reasonable equivalents thereof.

What is claimed is:

1. Apparatus for freezing in a desired geometric configuration, a portion of the water in a body of water, said apparatus comprising:

a plurality of elongated, generally vertically extending, spaced tubular members;

water impermeable, thermal insulation means extending along opposite sides of at least the lower portion of said tubular members and spaced horizontally therefrom to define an open-bottomed enclosure for confining quiescent water and through which said tubular members pass; and

a metal strip extending along the upper portion of said tubular members and having a lower edge positioned in juxtaposition to the upper portion of said thermal insulation means in the upper portion of said open-bottomed enclosure whereby ice formed in said open-bottomed enclosure will sealingly engage the lower edge of said metal strip.

2. Apparatus for freezing as defined in claim 1 and further characterized to include means for circulating a refrigerating medium through said elongated, generally vertically extending tubular members to freeze quiescent water in said open-bottomed enclosure.

3. Apparatus for freezing as defined in claim 1 wherein said plurality of elongated, generally tubular members are in a substantially circular array to collectively define a cylindrical structure, and said metal strip extends around and in contact with, the upper portion of said tubular members, said metal strip comprising two semicircular segments hinged to each other.

4. Apparatus for freezing as defined in claim 1 wherein said water impermeable, thermal insulation means comprises:

a first insulation-containing chamber on one side of said tubular members and spaced therefrom, said chamber comprising opposed sheets of a water impermeable material;

a second insulation-containing chamber on the opposite side of said tubular members from said first chamber, said chamber comprising opposed sheets of a water impermeable material;

thermal insulation contained in said first and second chambers between the opposed sheets of water impermeable material comprising said chambers; and means for supporting said first and second insulation-containing chambers in a fixed position relative to said tubular members and on opposite sides thereof.

5. Apparatus for freezing as defined in claim 4 wherein said means for supporting said first and second insulation containing chambers in a fixed position relative to said tubular members comprises:

an elongated, flexible sheet of material interconnecting said first and second insulation-containing chambers and extending over the upper ends of said elongated, generally vertically extending tubular members; and rigid means extending from said tubular members in

a common direction and having a frusto-conically shaped supporting surface supporting said first insulation-containing chamber.

6. Apparatus for freezing as defined in claim 1 wherein said plurality of elongated, generally tubular members are in a substantially circular array to collectively define a cylindrical structure;

and wherein said thermal insulation means includes a first portion extending around the inside of said cylindrical structure, and a second portion extending around the outside of said cylindrical structure.

7. Apparatus for freezing as defined in claim 6 wherein each of said portions of the thermal insulation means comprises a flexible material of good thermal insulating properties bounded by sheets of a water impermeable material.

8. Apparatus for establishing a submerged ice structure in a body of water comprising:

a plurality of elongated, generally vertically extending, spaced tubular members adapted to contain a heat exchange medium;

brace members extending horizontally in a common direction from the lower portions of each of said tubular members;

upwardly extending support rods secured to said brace members and having their lower ends spaced horizontally from said tubular members and their upper ends relatively closer to said tubular members than said lower ends;

an elongated, rigid perforated member extending along said tubular members and secured to and supported by said support rods, said perforated member having one longitudinal edge positioned adjacent the lower ends of said support rods and a second longitudinal edge positioned adjacent the upper ends of said support members;

water impermeable, thermal insulation means having

a first part extending downwardly along said tubular members on the opposite side thereof from the side of said tubular members from which said brace members extend, said first part extending from a vertical level substantially even with the upper ends of said support rods to a vertical level substantially even with the lower ends of said support rods; and

a second part superimposed over said rigid perforated member so that said first and second parts of said thermal insulation means are horizontally spaced from each other; and

a rigid strip of water impermeable material secured to the upper portions of said tubular members above said brace members and having a lower edge extending into the space between the first and second parts of said insulation means, and an upper edge extending substantially parallel to and spaced vertically from said lower edge.

9. An underwater structure comprising:

a plurality of elongated, generally vertically extending tubular members adapted to extend from the top of a body of water to the bottom thereof;

ice surrounding the lower portion of each of said tubular members and extending as a continuous, water impermeable wall between each adjacent pair of said tubular members; and

water impermeable, thermal insulation means positioned on opposite sides of said ice wall in contact therewith and spaced from said tubular members to form an enclosure containing said ice and tubular members; said tubular members being collectively disposed in a circular array, and said structure further being characterized to include water impermeable, rigid means sealingly engaged by said ice wall and extending upwardly therefrom and around said circular array of tubular members so that said ice wall and water impermeable, rigid means form a cofferdam structure.

10. An underwater structure as defined in claim 9 and further characterized to include sand mixed with said ice.

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11. An underwater structure as defined in claim 9 wherein said water impermeable ice wall is thicker in a horizontal direction at the lower portion thereof adjacent the lower ends of said tubular members than it is at the upper portion thereof, and uniformly changes in thickness over its vertical extent. 5

12. An underwater structure as defined in claim 9 wherein said water impermeable, thermal insulation means comprises a first part superimposed on said ice wall on one side thereof and a second part superimposed on said ice wall on the other side thereof, said first and second parts each comprising spaced sheets of flexible, water impermeable material and flexible thermal insulating material between said sheets. 10

13. The method of forming an ice structure in water comprising: 15

driving a plurality of elongated, vertically extending tubular members into the bottom beneath the body of water in which said structure is to be located;

positioning water impermeable, thermal insulation means on opposite sides of, and spaced from, said tubular members and extending upwardly from the bottom so as to define with said bottom, an enclosure containing quiescent water and extending along said tubular members a portion of the way to the surface of the body of water; 20

positioning a rigid strip of water impermeable material along said tubular members adjacent the upper portions thereof with a lower edge portion of said rigid strip of material extending into the quiescent water in said enclosure and the upper edge portion of said strip of material being located above the surface of the body of water; and 25

placing a refrigerating medium in said tubular members to freeze the quiescent water in said enclosure to form a solid ice wall around the lower portion of said tubular members and to sealingly engage said ice wall with said strip of water impermeable material. 30

14. Apparatus for freezing in a desired geometric configuration, a portion of the water in a body of water, said apparatus comprising: 40

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a plurality of elongated, generally vertically extending, spaced tubular members;

water impermeable, thermal insulation means extending along opposite sides of at least the lower portion of said tubular members and spaced horizontally therefrom to define an open-bottomed enclosure for confining quiescent water and through which said tubular members pass; and

rigid means extending from said tubular members in a common direction and supporting the portion of said water-impermeable, thermal insulation means on one side of said tubular members in a position in which the lowermost part of said thermal insulation means is farthest spaced from said tubular members, and said portion of said thermal insulation means is inclined continuously toward said tubular members from the lowermost part to the uppermost part thereof whereby said enclosure is thicker at the open bottom thereof than at the top thereof.

15. Apparatus for freezing as defined in claim 14 wherein said rigid means comprises:

brace members each having one end secured to one of said tubular members and extending horizontally outwardly from said tubular members in a common direction;

support rods secured to the free ends of said brace members and extending vertically upwardly and inclined toward said brace members at their upper ends; and

wire mesh supported on said support rods.

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