Feb. 1, 1966 S. D. MURPHY ETAL 3,232,064

THERMOELECTRIC ICE MAKING APPARATUS

Filed Nov. 27, 1964 2 Sheets-Sheet 1

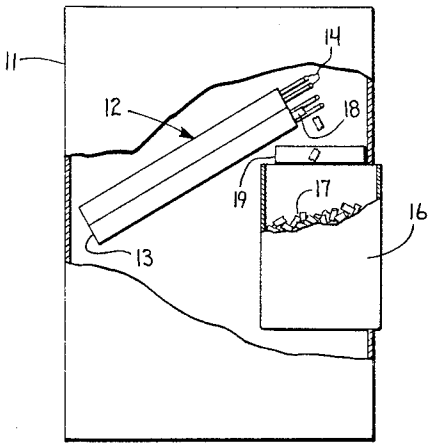


Fig. 1.

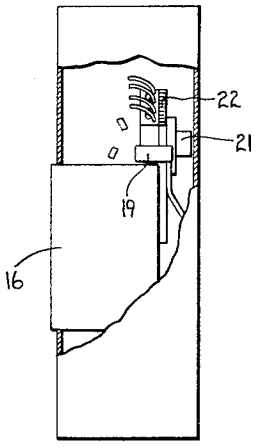


Fig. 2.

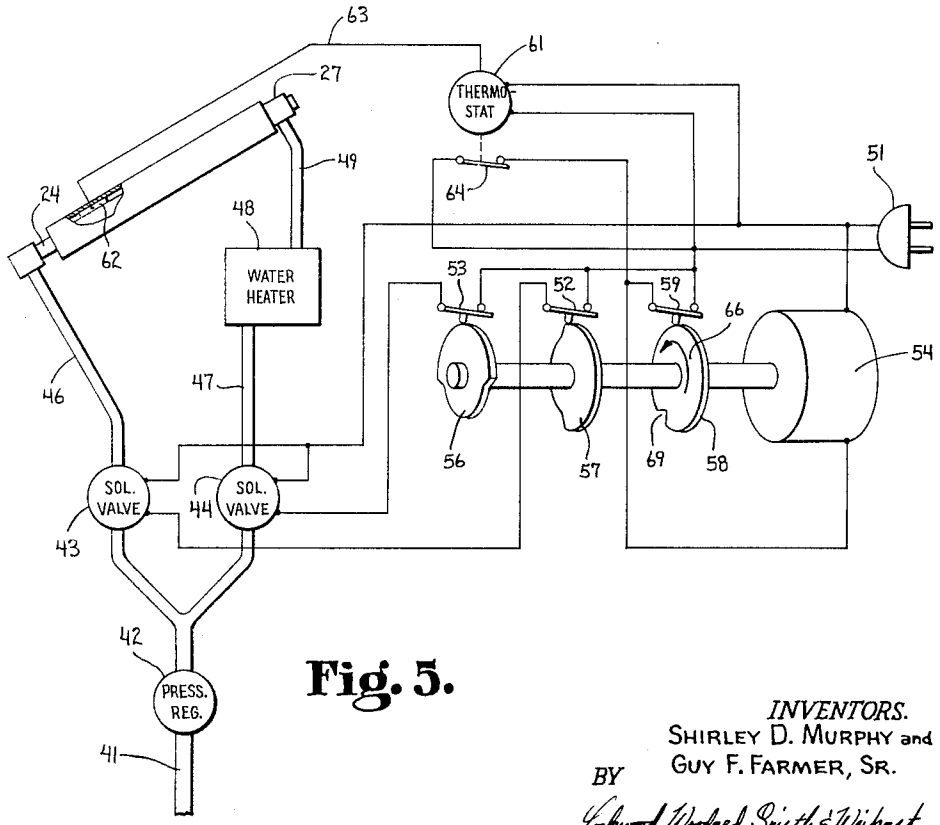


Fig. 5.

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THERMOELECTRIC ICE MAKING APPARATUS

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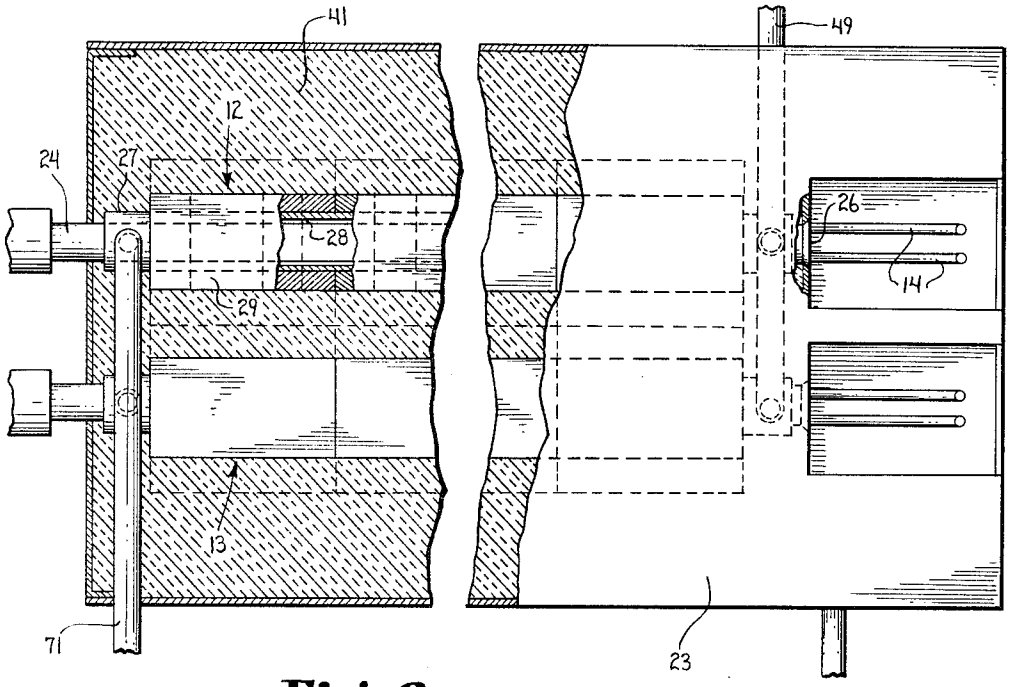


Fig. 3.

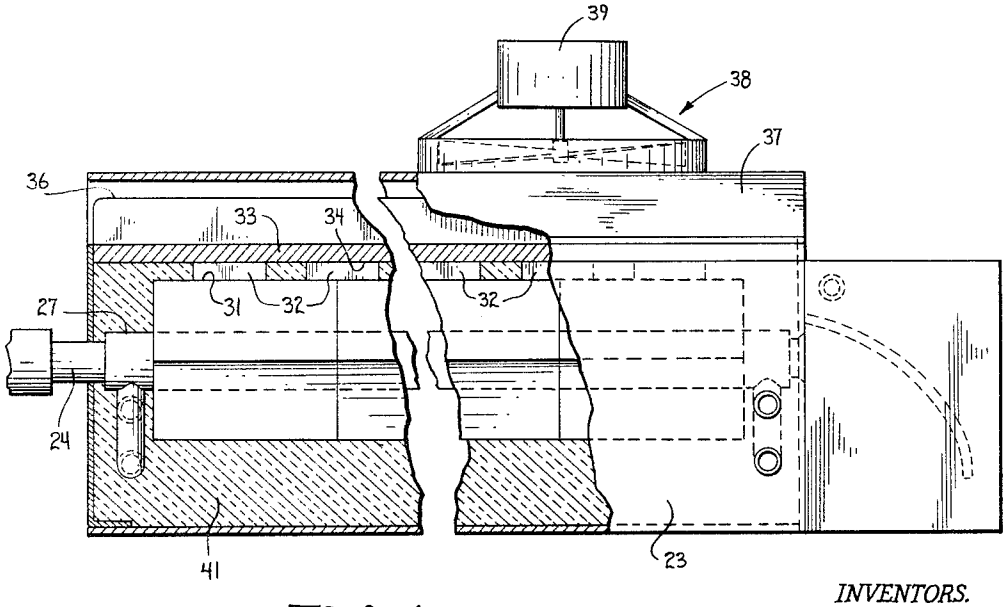


Fig. 4.

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THERMOELECTRIC ICE MAKING APPARATUS

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8 Claims. (Cl. 62—3)

This device relates generally to thermoelectric refrigerating devices and more particularly to machines for making ice in a solid, broken cylindrical form.

A number of ice making machines are known in the art. They have frequently been characterized by large size. Also, they have incorporated refrigeration equipment including coils, compressors, motors and other complex and comparatively expensive equipment subject to considerable mechanical maintenance.

It is, therefore, a general object of the present invention to provide an ice making machine utilizing thermoelectric principles of refrigeration.

A further object is to provide an ice making machine of comparatively simple and reliable construction.

A further object is to provide an ice making machine requiring very litle space.

A further object is to provide an ice making machine requiring comparatively less maintenance.

Described briefly, a typical embodiment of the present invention employs an elongated cylindrical tube mounted on some type of frame in an inclined attitude, this being the tube in which water is frozen to form ice rods. A second tube is disposed in closely spaced, coaxial relationship to the first tube and surrounding the first tube. This second tube is embedded in a highly conductive material which forms or is directly connected to the cold plates of a series of thermoelectric elements, these elements having a forced air cooled heat sink plate cooperating therewith whereby the outer and inner tubes are cooled well below the freezing temperature of water.

Timer controlled valve means are employed to supply water to the inner tube for freezing therein. Once water is frozen in the inner tube, a timer controlled valve is opened in response to the sensing of a temperature below freezing in the tubes, to supply hot water in the space between the tubes for releasing the ice in the inner tube. Water pressure applied to the inner tube ejects the ice therefrom and a pair of curved fingers at the outlet of the inner tube breaks the ice into conveniently sized cylindrical chunks.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims.

FIG. 1 is a somewhat schematic side elevational view (partially sectioned) of an ice making machine according to a typical embodiment of the present invention.

FIG. 2 is an end elevational view thereof.

FIG. 3 is a fragmentary enlarged side elevational view in partial section illustrating interior details of the freezing and thawing tube assembly.

FIG. 4 is a fragmentary enlarged top view thereof in partial section.

FIG. 5 is a schematic diagram of the water control system for one of the two freezing and thawing tube combinations of the preceding figures.

Referring now to the drawings in detail, the ice making machine may include a frame **11** which can have any of a variety of configurations, particularly in view of the compact nature of the functional elements of the apparatus. The illustrated embodiment has two freezing units **12** and **13**, each of which has a pair of curved deflecting fingers **14** at its upper end. An ice chunk receiving bin **16** is provided below the upper ends of the freezing units to receive the solid cylindrical ice chunks **17** which result

from the action of the fingers deflecting an ice rod **18** ejected from the end of a freezing tube in each of the freezing units.

A trough **19** is provided below the upper ends of the freezing units to receive any water which may momentarily overflow from the ends and empty it into a drain. A fan **21** is employed to circulate air over the cooling fin assembly **22** for the heat sink of the thermoelectric unit, these latter features being better illustrated in FIGS. 3 and 4 of the drawings.

Referring now specifically to FIGS. 3 and 4, the two freezing units **12** and **13** are disposed in a case **23** which is typically made of metal. Because the two units are identical, a detailed description on one will suffice. Freezing unit **12** includes a cylindrical tube **24** which is open at the upper end **26** thereof. A second cylindrical tube **27** surrounds the major portion of the first tube, is coaxial therewith, and is in closely spaced relationship thereto whereby an annular cylindrical space **28** is provided between the two tubes. The outer tube is embedded in an elongated heat transmitting body **29** which can be composed of a plurality of elongated blocks arranged in end-to-end abutting relationship and which, in the illustrated embodiment, are hexagonal in cross section although they could be square or have other configurations. These blocks, as well as the inner and outer tubes, are preferably made of materials exhibiting properties of high thermal conductivity. The radial dimension of the annular space between the tubes is typically greater than $\frac{1}{32}$ inch but less than $\frac{1}{8}$ inch.

The longitudinally extending flat surface **31** afforded by the heat transmitting member **29** makes an excellent cold plate for the plurality of thermoelectric refrigerating elements **32** disposed therealong. Such thermoelectric elements and their principles of operation are well known to those skilled in the art. As further shown in FIG. 4 particularly, a heat sink plate **33** has a flat surface **34** contacting the high temperature surfaces of the thermoelectric elements, and this plate is provided with a plurality of longitudinally extending radiating fins **36**. These fins are disposed perpendicular to the plane **34** of the base of the heat sink plate. This plate can typically be a solid extruded homogeneous mass of a material having excellent thermal conductivity. The thermoelectric elements are in direct thermal contact with the near surfaces of the hexagonal blocks forming the heat transmitting member **29** and with the flat surface **34** of the heat sink plate, but the elements are electrically insulated from these surfaces for proper operation of the thermoelectric elements. In this manner, the heat transmitting member can readily be reduced to a temperature well below the freezing point of water.

The heat sink fins are enclosed, except on each end, within a shroud **37**, on which is mounted a fan **38** driven by a motor **39**, so that air is forced by the fan through the spaces between the heat sink fins and exits through the shroud openings at opposite ends of the heat sink, thereby removing heat which is produced on the heat sink by the thermoelectric elements.

Thermal insulating material **41** is provided which totally encloses and is in contact with all exterior points of the heat transmitting member **29** except where a thermoelectric element **32** is in contact therewith and where one of the two tubes **27** and **24** enters the member.

Referring now to FIG. 5, a water supply under pressure is provided from the source which is illustrated in the form of a water main **41** which is connected through a pressure regulator **42** to a pair of solenoid valves **43** and **44**. Both of these valves are normally closed and the outlet from the valve **43** is connected through a line **46** to the inner tube **24**, which is the water freezing tube.

A water line 47 is connected from the other valve 44 to a water heater 48 having a hot water outlet line 49 connected to the upper end of the outer tube 27.

A plug 51 is provided for connection to a source of electrical energy which can typically be 110 volt A.C., and each of the solenoids is connected to one side if the plug 51 and solenoid 43 is connected to the other side through a normally open cam-operated switch 52, whereas solenoid 44 is connected to the other side of the plug through a normally open cam-operated switch 53. Operation of these switches is provided by a motor 54 driving cams 56 and 57, as well as a cam 58 used for closing a motor holding circuit. Switch 59, operated by cam 58, is also a normally open switch. All of these switches are shown in the closed condition which typically occurs regularly during the use of the ice making apparatus.

Further with reference to FIG. 5, a thermostat 61, also energized by way of the plug 51 has a temperature sensing element 62 connected thereto through the line 63, this element normally being located on the inner tube 24 near the lower end of the freezing unit. The thermostat is set at a temperature of 15° F. approximately so that it will close the normally open switch 64 when the temperature in the freezing tube falls to this level, indicating that there is ice in the freezing tube. The distance of the sensor from the lower end of the outer tube 27, and the setting of the thermostat 61 are such that there is no danger of solidification of water in the tube 24 below the lower end of the tube 27.

OPERATION

Assuming that the device has been in operation for a period of time, there is hot water in the heater 48 and the thermoelectric elements have frozen water in the tube 24. There is nothing but air in the space 28 between the inner and outer tube.

The sensing element 62 responds to this condition by causing the thermostat to close switch 64. This initiates operation of the motor 54 which will be assumed to rotate the cams in the direction of the arrow 66. Immediately, cam 58 moves from the position where the notch 69 therein would allow the switch 59 to be open, and closes switch 59 which places a motor holding circuit in operation from the plug through the motor and switch 59 back to the plug 51. Shortly thereafter, the cam 56 closes the switch 53 energizing solenoid 44 which causes water leaving the regulator 42 to enter the heater forcing hot water through the line 49 into the outer tube 27 whereupon it runs down through the space 28 and out the drain 71. This hot water initiates thawing between the ice in the inner tube and the wall of the inner tube to release the ice therein. Thereupon the cam 57 closes switch 52 opening the valve 43 and applying water pressure through the line 46 to the tube 24 which forces the ice out of the tube 24, the ice having been released by the water.

As the ice, which is now in the form of a rod of ice, is ejected from the upper end of the tube 24, it encounters the curved fingers 14 which bend the rod and break it into the chunks 17 (FIG. 1).

The pressure regulator reduces the pressure in line 46 to a value less than water main pressure, to avoid a blast of water at the exit of the inner tube when the ice rod has been partially or entirely rejected.

Meanwhile, cam 56 has allowed the solenoid 44 to become de-energized whereupon the supply of water to the heater is interrupted and no more hot water flows into the outer tube. All of the water in the tube thereby drains out of the drain 71. Of course the hot water in the outer tube raises the temperature of the sensor whereupon the thermostat opened the motor switch 64 whereupon the motor holding circuit took over to continue operation of the motor. When sufficient time has elapsed for the water in line 46 to push the ice rod out of the tube 24, tube 24 will again be full of water and the cam 57 will allow switch 52 to open whereupon solenoid 43 will be de-energized and the valve will close. The freezing cycle begins again. Shortly thereafter, the cam 58 will have returned to the point where the notch 69 therein will allow the motor holding switch 59 to open whereupon the motor operation will cease until the thermostat sensor again detects such a low temperature in the tube 24 to indicate that it is again full of ice.

Although the controls and valving have been described for only the freezing cylinder assembly 12, the same arrangement can be used for the freezing cylinder assembly 13. If desired, each of a plurality of freezing cylinder assemblies can be cycled in such a manner that ice would be constantly exiting from the apparatus.

From the foregoing description, it is believed apparent that the present invention provides a simple, compact, reliable, and relatively maintenance-free type of apparatus of a very advantageous nature. Although the invention has been disclosed and described in some detail in the drawings and foregoing description, they are to be considered as illustrative and not restrictive in character, as other modifications may readily suggest themselves to persons skilled in this art and within the broad scope of the invention, reference being had to the appended claims.

The invention claimed is:

1. An ice making machine comprising:
a frame;
a water freezing tube affixed to said frame and having an inclined longitudinal axis;
a thawing tube coaxial with and surrounding said freezing tube;
a refrigerating device removing heat from said freezing tube;
a first valve for admitting water to said freezing tube;
a second valve for admitting water to said thawing tube;
a source of water under pressure coupled to said first valve;
a source of hot water coupled to said second valve;
and timer means connected to said first and second valves and operable on said second valve to admit hot water to said thawing tube to release the ice formed in said freezing tube, and operable on said first valve to admit water to said first tube when said ice is released to force said ice from said first tube and replenish said first tube with water.

2. Ice making apparatus comprising:
a stationary frame;
a case affixed to said frame and containing insulating material;
a first plurality of blocks of hexagonal cross section stacked end-to-end in a line in said case, said blocks being made of a material of high thermal conductivity and said blocks presenting a linearly extending common flat surface in a plane;
a first outer tube in said case having a portion embedded in said plurality of blocks;
a first inner tube coaxial with said outer tube and disposed inside said outer tube, the outer surface of said inner tube being equidistant from the inner surface of the outer tube throughout most of the length of said outer tube, both of said tubes being fixed on an incline in said frame;
a heat sink plate having a base with a flat surface disposed in parallel horizontally-spaced relationship to said common flat surface of said blocks, said heat sink plate being of a material of high thermal conductivity with a plurality of radiating fins disposed perpendicular to said base and extending therealong, projecting in a direction away from said hexagonal blocks;
a plurality of thermoelectric elements disposed in the space between the flat surface of said heat sink plate and said common flat surface of said hexagonal

blocks in direct thermal contact and electrically insulated contact with said heat sink plate and said blocks, thereby causing said heat sink plate with said radiating fins to provide the hot terminals for said elements and the said hexagonal blocks to provide the cold terminals for said elements;
a shroud enclosing said radiating fins throughout a substantial portion of their length and open at opposite ends;
a power driven fan connected to said shroud for driving heat out of said shroud from between said fins;
a first inlet line connected to the lower end of said inner tube;
a second inlet line connected to said outer tube near the upper end thereof and having an outlet at the lower end thereof providing a drain;
a pressure regulator connected to a source of water under pressure and connected through a first solenoid-operated valve to said first line for admitting water under pressure to said inner tube, and a second solenoid-operated valve connected from said regulator through a water heater to said second line connected to said outer tube;
control means coupled to said valves and including temperature sensing means responsive to formation of an ice rod in said inner tube to open said valves for admitting hot water to the space between said tubes and thereby thaw ice in said inner tube, and for applying pressure to the lower end of the ice in said inner tube for ejection of the ice;
timing means in said control means and initiated by said sensing means, and coupled to said valves for limiting the quantity of hot water supplied to said space and for limiting the duration of application of pressure to said ice rod, to allow filling of said inner tube with a predetermined amount of water;
an ice depository;
curved finger means at the exit of said inner tube guiding and breaking ice ejected from said inner tube during ejection thereof, said fingers being disposed so that said exiting ice, when broken, is discharged into said depository;
and means adjacent the upper end of said inner tube directing any water discharged therefrom to a drain.

3. An ice making apparatus comprising:
a frame;
a first tube with means connected thereto for admitting a predetermined amount of water thereto and holding said water therein;
a shell spaced from and covering a predetermined portion of the length of said tube;
means coupled to said shell for admitting a hot fluid to the space between said shell and said tube;
refrigerating means including a heat transmitting member receiving said shell and removing heat therefrom, said shell removing heat from said first tube whereby water in said first tube is frozen therein;
timer means coupled to said admitting means and controlling duration of admission of said water and hot fluid;
and a temperature sensor responsive to fall in temperature in said first tube to initiate admission of said water and said fluid, said fluid, when admitted, thawing ice at the area of contact thereof with the tube to release the ice in the tube;
and the admitted water being pressurized sufficiently to expel the released ice from said tube in the form of a rod of ice.

4. An ice making apparatus comprising:
a frame;
a first tube with means connected thereto for admitting a predetermined amount of water thereto and holding said water therein;

a shell spaced from and covering a predetermined portion of the length of said tube;
means coupled to said shell for admitting a hot fluid to the space between said shell and said tube;
refrigerating means including a heat transmitting member receiving said shell and removing heat therefrom, said shell removing heat from said first tube whereby water in said first tube is frozen therein;
said refrigerating means also including a plurality of thermoelectric elements spaced along said heat transmitting member.

5. An ice making apparatus comprising:
a frame;
a first tube with means connected thereto for admitting a predetermined amount of water thereto and holding said water therein;
a shell spaced from and covering a predetermined portion of the length of said tube;
means coupled to said shell for admitting a hot fluid to the space between said shell and said tube;
refrigerating means including a heat transmitting member having said shell imbedded therein and removing heat therefrom, said shell removing heat from said first tube whereby water in said first tube is frozen therein.

6. An ice making apparatus comprising:
a frame;
a first tube with means connected thereto for admitting a predetermined amount of water thereto and holding said water therein;
a second tube spaced from and covering a predetermined portion of the length of said first tube;
means coupled to said second tube for admitting a hot fluid to the space between said second tube and said first tube;
refrigerating means including a heat transmitting member receiving said second tube and removing heat therefrom, said second tube removing heat from said first tube whereby water in said first tube is frozen therein.

7. An ice making apparatus comprising:
a frame;
a first cylindrical tube with means connected thereto for admitting a predetermined amount of water thereto and holding said water therein;
a second cylindrical tube coaxial with said first tube and spaced from and covering a predetermined portion of the length of said first tube;
means coupled to said second tube for admitting a hot fluid to the space between said second tube and said first tube;
refrigerating means including a heat transmitting member receiving said second tube and removing heat therefrom, said second tube removing heat from said first tube whereby water in said first tube is frozen therein.

8. Ice making apparatus comprising:
a stationary frame;
a case affixed to said frame and containing insulating material;
a first plurality of blocks of hexagonal cross section stacked end-to-end in a line in said case, said blocks being made of a material of high thermal conductivity and said blocks presenting a linearly extending common flat surface in a plane;
a first outer tube in said case having a portion embedded in said plurality of blocks;
a first inner tube coaxial with said outer tube and disposed inside said outer tube, the outer surface of said inner tube being equidistant from the inner surface of the outer tube throughout most of the length of said outer tube, both of said tubes being fixed on an incline in said frame;
a heat sink plate having a base with a flat surface disposed in parallel horizontally spaced relationship

to said common flat surface of said blocks, said heat sink plate being of a material of high thermal conductivity with a plurality of radiating fins disposed perpendicular to said base and extending therealong, projecting in a direction away from said hexagonal blocks;

a plurality of thermoelectric elements disposed in the space between the flat surface of said heat sink plate and said common flat surface of said hexagonal blocks in direct thermal contact and electrically insulated contact with said heat sink plate and said blocks, thereby causing said heat sink plate with said radiating fins to provide the hot terminals for said elements and the said hexagonal blocks to provide the cold terminals for said elements;

a shroud enclosing said radiating fins throughout a substantial portion of their length and open at opposite ends;

a power driven fan connected to said shroud for driving heat out of said shroud from between said fins;

a first inlet line connected to the lower end of said inner tube;

a second inlet line connected to said outer tube near the upper end thereof and having an outlet at the lower end thereof providing a drain;

a pressure regulator connected to a source of water under pressure and connected through a first solenoid-operated valve to said first line for admitting water under pressure to said inner tube, and a second solenoid-operated valve connected from said regulator through a water heater to said second line connected to said outer tube;

control means coupled to said valves and including temperature sensing means responsive to formation of an ice rod in said inner tube to open said valves for admitting hot water to the space between said tubes and thereby thaw ice in said inner tube, and for applying pressure to the lower end of the ice in said inner tube for ejection of the ice;

timing means in said control means and initiated by said sensing means, and coupled to said valves for

limiting the quantity of hot water supplied to said space and for limiting the duration of application of pressure to said ice rod, to allow filling of said inner tube with a predetermined amount of water;

an ice depository;

curved finger means at the exit of said inner tube guiding and breaking ice ejected from said inner tube during ejecting thereof, said fingers being disposed so that said exiting ice, when broken, is discharged into said depository;

and means adjacent the upper end of said inner tube directing any water discharge therefrom to a drain;

a second plurality of hexagonal blocks containing a second outer tube and a second inner tube coaxial with said second outer tube;

and means admitting water to said second inner tube and hot water to said second outer tube at predetermined times and in predetermined amounts;

and thermoelectric elements connected to said second plurality of blocks and said heat sink plate for making ice in said second inner tube;

and curved fingers at the exit of said second inner tube to deflect the ice rod ejected therefrom and break the ice into chunks and deposit them in said depository.

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