Sept. 1, 1964 W. H. GRIMES ETAL 3,146,606

APPARATUS FOR MAKING CLEAR ICE BODIES

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Fig. 1.

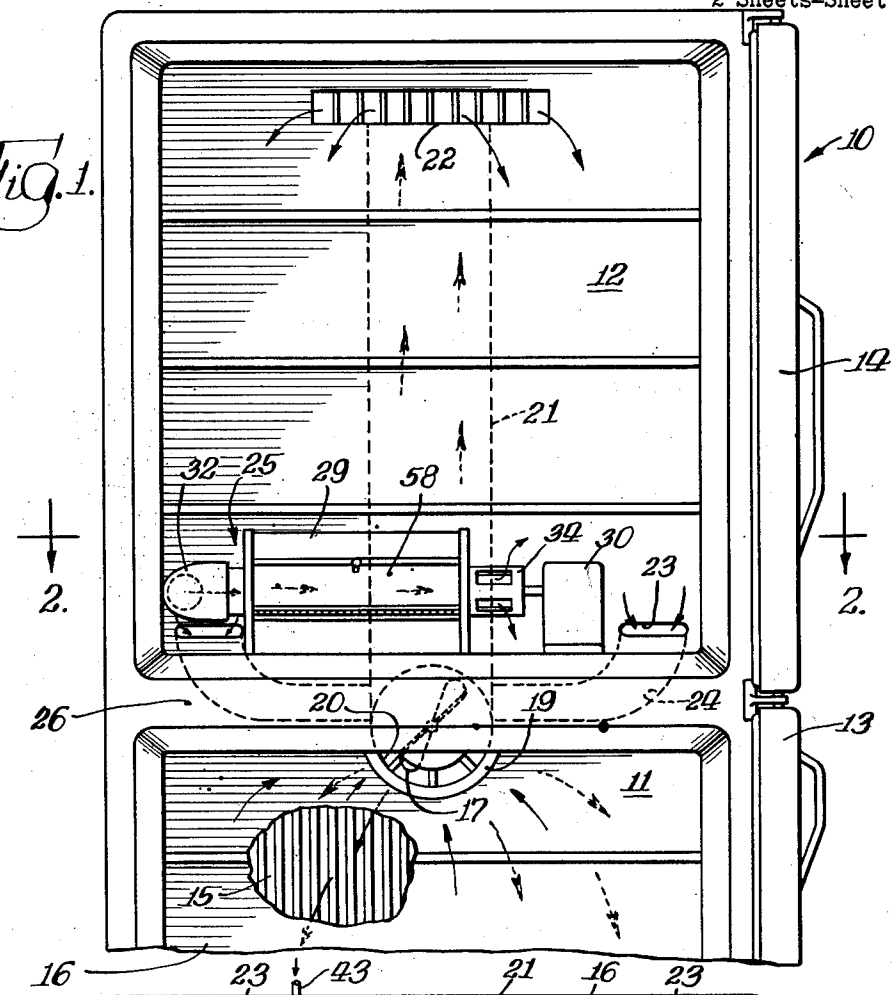
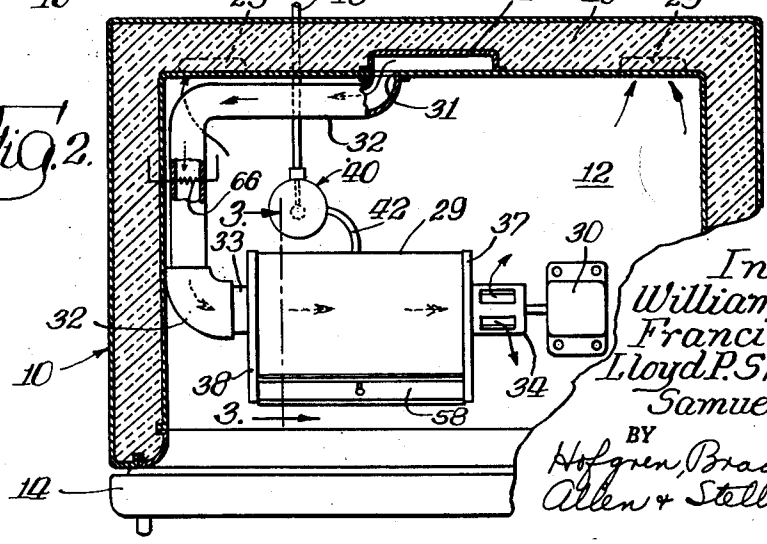


Fig. 2.



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Fig. 3.

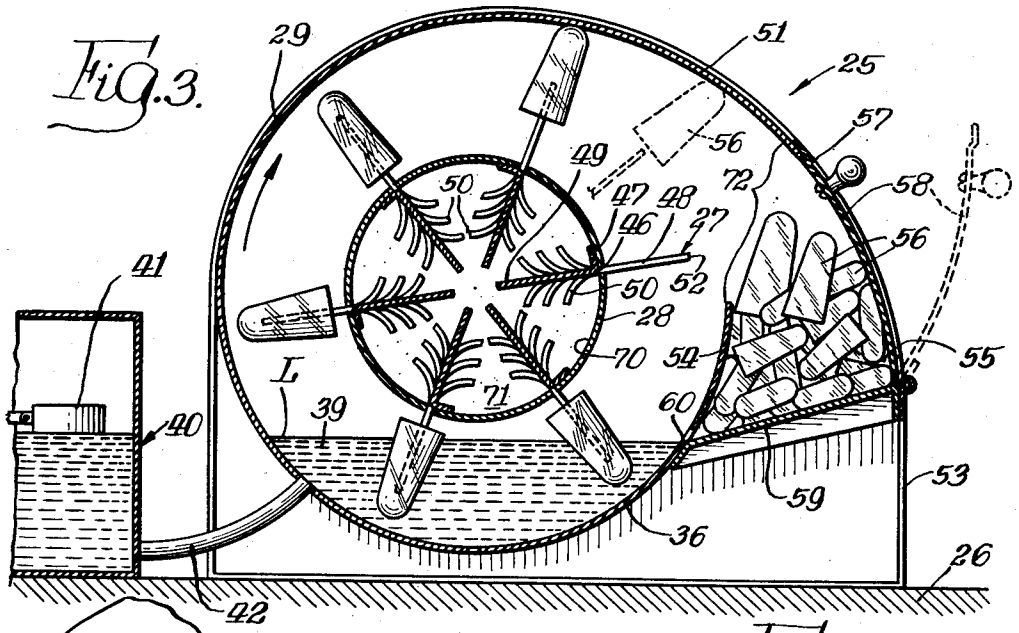


Fig. 5.

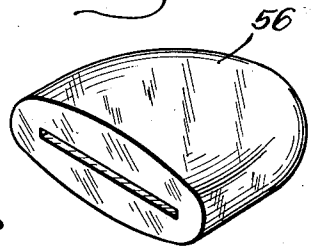


Fig. 4.

Fig. 6.

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APPARATUS FOR MAKING CLEAR ICE BODIES

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This invention relates to ice makers and in particular to ice makers arranged for producing clear ice.

In conventional ice makers, as utilized in household refrigerators and the like, means are provided for freezing water in trays or molds as by locating the trays or molds in a below-freezing space. In such conventional ice body forming devices, the slow freezing of the ice bodies by the cooling of water in a quiescent state from the outside inwardly causes expansion cracks to form therein and permits impurities and/or air bubbles to be trapped within the ice body, thereby reducing the clarity thereof. The present invention comprehends a new and improved apparatus for making ice bodies effectively precluding the formation of such expansion cracks and preventing the occlusion of such impurities and/or air bubbles in the formed ice bodies, thus providing highly transparent and clear ice bodies.

Thus, a principal feature of the present invention is the provision of a new and improved apparatus for making clear ice bodies.

Another feature of the invention is the provision of such an apparatus including a forming member formed of a thermally conductive material and having spaced first and second portions, means for holding a body of water, means for moving the first portion of the forming member into the body of water, and means for withdrawing heat energy from the second portion of the forming member thereby to conduct heat from the first portion to freeze a body of ice thereon.

A further feature of the invention is the provision of such an apparatus including means for directing a body of fluid having a temperature no greater than 32° F., against the second portion of the forming member thereby to conduct heat from the first portion to freeze the ice body thereon.

Still another feature of the invention is the provision of such apparatus having a hollow member carrying the forming member with the first portion of the forming member exposed exteriorly of the hollow member and the second portion disposed within the hollow member, and means for directing a body of fluid having a temperature no greater than 32° F., through the interior of the hollow member to refrigerate the forming member.

Another feature of the invention is the provision of such apparatus including a hollow, rotatable member with means for forming ice bodies on the outer portions thereof, means within the hollow member in heat transfer relation with the outer portions, and means for directing a body of heated fluid, having a temperature greater than 32° F., through the hollow member to effect the release of the ice bodies from the outer portions of the hollow member.

A further feature of the invention is the provision of such an apparatus wherein the fluid passed through the hollow member is further directed through the space surrounding the apparatus for refrigerating that space.

Another feature of the invention is the provision of such apparatus wherein the hollow member is rotatable about an axis thereof to move the forming members carried thereon through the body of water.

Still another feature of the invention is the provision of such apparatus wherein the rotatable hollow member has forming members of improved configuration to increase the effectiveness of both the freezing and the releasing phases of ice body production.

A further feature of the invention is the provision of such apparatus wherein means for rotating the hollow member comprises means arranged to rotate the hollow member at a low speed in an ice body forming cycle thereof, and at a high speed in an ejecting cycle thereof.

Still another feature of the invention is the provision of such an apparatus having new and improved means for releasing the ice bodies from the forming member for ejection thereof to a collecting space. Another feature of the invention is the provision of such an apparatus in an above-freezing atmosphere wherein means are provided for transferring the melt of the ice bodies within the collecting space back to a space adjacent the forming members for subsequent re-freezing thereon.

A further feature of the invention is the provision of such apparatus having improved means for releasing the ice bodies from the forming members including housing means of such configuration to assist in guiding the released ice bodies from the forming members to the collecting space.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a fragmentary front elevation of a refrigerator provided with an apparatus embodying the invention for making clear ice bodies;

FIGURE 2 is a horizontal section thereof taken substantially along the line 2—2, with a portion thereof broken away to facilitate the illustration thereof;

FIGURE 3 is a fragmentary, enlarged vertical section taken substantially along the line 3—3 of FIGURE 2;

FIGURE 4 is a fragmentary, isometric view of the ice body maker;

FIGURE 5 is a isometric view of an ice body as formed by the ice body maker; and

FIGURE 6 is a schematic diagram illustrating the electrical connections of the apparatus.

In the exemplary embodiment of the invention as disclosed in the drawing, a refrigerator generally designated **10** is arranged to define a below-freezing compartment **11** and an above-freezing compartment **12** selectively closed by doors **13** and **14** respectively. An evaporator **15** is disposed within the wall **16** defining one portion of chamber **11**, and an air moving means, herein a fan **17** driven by a suitable motor **18**, is disposed within a shroud **19** directly above evaporator **15**. Shroud **19** is provided with suitable openings **20** communicating with chamber **11** whereby air is drawn by fan **17** through openings **20** and delivered downwardly therefrom through evaporator **15** back into chamber **11** whereby chamber **11** is maintained at a preselected sub-freezing temperature. Fan **17** further directs a body of air upwardly through a duct **21** extending within wall **16** to substantially the top of chamber **12** and opening thereat into chamber **12** through an outlet **22**. After passing through chamber **12**, the air exits therefrom through a plurality of outlets **23** adjacent the bottom thereof and passes back to fan **17** through suitable ducts **24** extending between outlets **23** and shroud **19**. Thus, the refrigeration of chamber **12** is effected by the mixing of the air returned therefrom to fan **17** with the relatively cold air returned to the fan **17** from the chamber **11** and the delivery of the resultingly cooled mixture to chamber **12**. Herein the temperature of the air delivered through duct **21** is approximately 18° F. to 20° F., whereas the air delivered to chamber **11**, after passing through evaporator **15**, may have a temperature of approximately 0°F.

As shown in FIGURES 1 and 2, an apparatus for making ice bodies comprising ice body maker **25** is disposed in chamber **12** on the dividing wall **26** separating cham-

ber 12 from chamber 11. The ice body maker 25 includes a plurality of forming members 27 carried by a hollow tubular member 28 in a space 29a enclosed by a housing, and rotated about its longitudinal axis by a motor 30. A portion of the refrigerated air in duct 21 is delivered through an opening 31 to a conduit 32 and on into one end 33 of the hollow member 28, end 33 being slidably assembled within conduit 32 to allow free rotation of hollow member 28 by motor 30. The opposite end 34 of the hollow member 28 is provided with a plurality of rectangular slots 35 opening to chamber 12 whereby the refrigerated air may pass from conduit 32 through hollow member 28 and slots 35 therein into chamber 12 for return to fan 17 through outlets 23 and ducts 24.

Housing 29 defines a scroll-like enclosure having its longitudinal axis generally parallel to the longitudinal axis of hollow member 28. A lower, segmentally cylindrical portion 36 of the housing defines, with a pair of end walls 37 and 38 at the longitudinally opposite ends of the housing, a receptacle for holding a body of water 39. The body of water 39 is maintained at a preselected level L by a suitable supply device 40 including a float controlled valve 41 and connected to the lower portion 36 of the housing 29 by a suitable tube 42. As best seen in FIGURE 3, level L is slightly below the hollow member 28, herein the spacing therebetween may be approximately one-quarter inch.

Referring now more specifically to FIGURES 3 and 4, tubular member 28 which has an interior surface 70 defining a passageway 71 is formed of a thermally insulating material, such as a plastic, or of metal coated with a waterproof insulating material and is journalled in the end walls 37 and 38 of the housing 29 for rotation by motor 30 connected to an axially projecting shaft 44 secured in the end 34 of the tubular member by a plug 45. The forming members 27 are carried by the tubular member 28 intermediate the end walls 37 and 38 in a longitudinally and circumferentially spaced distribution. The forming members are preferably formed of a thermally conducting material, such as copper, and include a mid-portion 46 extending through the tubular member 28 and secured to the interior surface 70 by a flange 47. The portion of the forming member extending outwardly of the tubular member 28 comprises a thin, flat paddle 48 having a length substantially greater than the minimum spacing between the tubular member and the water level L (herein greater than ¼ inch) so as to extend into the body of water 39 during the lower portion of the travel of the forming members about the axis of tubular member 28. Each paddle 48 has a pair of oppositely disposed face portions 73 and a pair of outwardly converging end portions 74, these end portions terminating in an edge portion 75. The end portions 74, the edge portion 75 and the tubular member 28 define the shape of the face portions 73, the preferred shape being a trapezoid which assists the ice body in sliding from the paddle during the ice releasing phase.

The portion of each forming member 27 disposed within the passageway 71 of tubular member 28 comprises a fin 49 provided with a plurality of heat transfer fingers 50 upset therefrom. As best seen in FIGURE 3, the flat plane of each forming member is preferably an axial plane whereby the paddles 48 move through the water 39 in a broadside fashion.

As best seen in FIGURE 3, the cross section of housing 29 is generally cylindrical. However, the upper front portion 51 of the housing 29 deviates outwardly from the cylindrical configuration to provide a gradually increasing spacing between the outer tip 52 of the forming members 27 as the forming members move in a clockwise direction. The lower end 53 of housing portion 51 is thusly spaced forwardly of the upper end 54 of the housing portion 36 thereby defining an opening 72 leading to a collecting space 55 for receiving and storing a plurality of ice bodies 56 formed in the apparatus 25. The

housing portion 51 further defines an access opening 57 selectively closed by a door 58 for removal of the collected ice bodies as desired. As shown in FIGURE 3, the bottom of the space 55 is defined by a shelf 59 which is inclined downwardly from housing front 53 to portion 36 at level L. The housing portion 36 is provided with a small aperture 60 immediately above the level L permitting any melt from the collected ice bodies 56 to pass back into the body 39 of water in the housing portion 36.

The operation of apparatus 25 is extremely simple. As seen in FIGURE 6, the refrigerator compressor 61 is connected in series with a thermostat switch 62 between the power supply leads L1 and L2. Motor 18 driving fan 17 is connected between the leads L1 and L2. The drive motor 63 of a timer mechanism 64 is connected between leads L1 and L2. A first, normally open switch 65 of timer mechanism 64 is connected in series with a heater coil 66 between leads L1 and L2, and a second, normally open switch 67, of timer mechanism 64 is connected in series with the drive motor 30 of apparatus 29 between the power supply leads L1 and L2. A speed reducing resistor 68 is connected in parallel with switch 67 to provide a reduced voltage across motor 30 whenever switch 67 is open, and, thus, cause operation of the motor 30 at a reduced speed such as 25 revolutions per minute.

At the beginning of the ice body forming operation, timer 64 is arranged to have switches 65 and 67 open as shown in FIGURE 6. Thus, motor 30 is operating at the low speed provided by voltage dropping resistor 68 and the paddles 48 are moved seriatim slowly into and from the body of water 39. The sub-freezing air passed through the passageway 71 from ducts 21 and 32 cools the forming member portions 49, thereby drawing heat from the paddles 48 and transferring the heat to the sub-freezing air. Resultingly, a layer of ice forms on each paddle as it moves through the body of water 39 which, after sufficient passes have been made, forms the completed ice body 56. As the ice bodies are frozen from the inside thereof outwardly, i.e., from the paddles 48 outwardly, expansion cracks in the ice bodies are effectively eliminated. Further, as a result of the movement of the congealing water as the ice layer is formed, impurities and/or air bubbles are prevented from being trapped within the ice body. Thus, a substantially transparent, highly clear ice body 56 results.

After a preselected time, motor 63 drives the timer mechanism 64 sufficiently to close the switches 65 and 67. The closing of switch 65 energizes the heater 66, which as shown in FIGURE 2, is disposed within the conduit 32 thereby heating the air delivered to the interior of the tubular member 28. Illustratively, heater 66 may have a capacity of approximately 25 watts; such a heater has been found to be capable of raising the temperature of the air delivered to the tubular member to approximately 60° F. This warm air contacting the fan portions 49 of the forming members causes heat to be conducted outwardly to the paddle portions 48 thereby melting the surface of the ice bodies confronting the paddles and thereby freeing the ice bodies for subsequent ejection. The closing of switch 67 shorts out the resistor 68 thereby connecting the motor 30 directly between the leads L1 and L2 and causing the motor to run at its normal full speed. At this speed the rotational velocity of the tubular member 28 increases sufficiently to impart a centrifugal force to the freed ice bodies on the paddles 48 causing the ice bodies to be thrown free of the paddles as they move adjacent the housing portion 51, as shown in dotted lines in FIGURE 3. The centrifugally ejected ice body is thusly thrown outwardly through opening 72 and into space 55 where it is stored for withdrawal through the opening 57 as desired. As the temperature in chamber 12 is an above-freezing temperature, the ice bodies may slowly melt, the melt being returned to the body of water 39 through the aperture 60 as discussed above.

After a preselected time, the timer motor 63 reopens

the switches 65 and 67 thereby re-initiating an ice body forming cycle as discussed above.

While we have shown and described one embodiment of our invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:

1. Apparatus for making clear ice bodies, comprising: a tubular hollow member formed of an insulating material; a forming member formed of thermally conductive material and having spaced first and second portions, said forming member being carried by said hollow member to have said first portion exposed exteriorly of the hollow member and said second portion disposed within said hollow member; means for holding a body of water; means for rotating said tubular member about its longitudinal axis to move said first portion of the forming member through the body of water, said moving means being arranged to rotate said tubular member selectively at a low speed and a high speed; and means for selectively directing a body of fluid having a temperature no greater than 32° F., against said second portion of the forming member while said moving means is rotating said tubular member at the low speed thereby to conduct heat from said first portion to freeze a body of ice therein, and directing a body of fluid having a temperature greater than 32° F., against said second portion of the forming member while said moving means is rotating said tubular member at the high speed thereby to deliver heat to said first portion to release the body of ice therefrom and permit the ice body to move outwardly from the forming member as a result of centrifugal force.

2. Apparatus for making clear ice bodies, comprising: a housing including means for retaining a body of water; a hollow tubular member rotatably supported by said housing and having an interior surface defining a passageway; means for forming ice bodies exteriorly of said tubular member including heat transfer means having an outer portion externally of the tubular member and an inner portion within said passageway; and means for periodically supplying heated air through said passageway and over said heat transfer means thereby to effect the release of said ice bodies from said tubular member.

3. Apparatus for making clear ice bodies, comprising: a housing including means for retaining a body of water; a hollow tubular member rotatably supported by said housing and having an interior surface defining a passageway; a plurality of spaced forming members of thermally conductive material attached to said tubular member, each of said forming members including a first portion extending outwardly from said tubular member, and a second portion extending inwardly into said passageway; means for circulating below freezing air through said passageway and in heat transfer relation with the second portions of said tubular members; drive means for rotating said tubular member whereupon the first portions of said forming members pass through said body of water for freezing an ice body thereon; heater means associated with said air circulating means for transforming below freezing air to above freezing air; and control means for periodically initiating said heater means thereby effecting the release of said ice bodies from said forming members.

4. Apparatus for making clear ice bodies, comprising: a housing including means for retaining a body of water; a hollow tubular member rotatably supported by said housing and having an interior surface defining a passageway; forming means for forming ice bodies on said tubular member including heat transfer means within said passageway; means, including a heater, for supplying heated air through said passageway and over said heat transfer means; drive means attached to said tubular member for rotating said tubular member; and control means for periodically initiating said heater and increasing the rotational velocity of said tubular member whereupon the heat and centrifugal force effect the release of said ice bodies from said forming means.

5. The ice making apparatus of claim 4 wherein a first portion of each of said forming means defines a pair of oppositely disposed trapezoidal face portions exteriorly of said tubular member.

6. The ice making apparatus of claim 4 wherein said drive means includes a motor for rotating said tubular member at a first slow rotational velocity during formation of ice bodies on said tubular member and at a second high rotational velocity during the release of said ice bodies from said tubular member.

7. Apparatus for making clear ice bodies, comprising: a hollow tubular member having an interior surface defining a passageway; means for forming ice bodies on said tubular member including heat transfer means within said passageway; means, including a heater, for supplying heated air through said passageway and over said heat transfer means; drive means attached to said tubular member for rotating said tubular member; and a scroll-shaped housing having an opening, said housing rotatably supporting said tubular member; means defining a collecting space adjacent said housing and in communication with said opening; and control means for periodically initiating said heater and increasing rotational velocity of said tubular member for effecting the release of said ice bodies therefrom, said housing guiding the released ice bodies outwardly through said opening and into said collecting space.

8. The apparatus of claim 7 wherein said forming means comprise a plurality of thin metal paddles, said paddles including a pair of trapezoidal face portions for assisting the release of said ice bodies therefrom.

9. In a refrigerator, an above-freezing compartment, and an apparatus within said compartment for making clear ice bodies, said ice body maker comprising: a housing including means for retaining a body of water; a hollow tubular member rotatably supported by said housing and having an interior surface defining a passageway, said tubular member having an opening communicating with said compartment; a plurality of spaced forming members of thermally conductive material attached to said tubular member, each of said forming members including a first portion extending outwardly from said tubular member and a second portion extending inwardly into said passageway; means for supplying below-freezing refrigerated air into said passageway, into heat transfer relation with the second portion of said forming members and subsequently into said above-freezing compartment through said opening; and drive means for rotating said tubular member whereby the first portions of each of said forming members pass into and out of said body of water for freezing incremental layers of ice thereon.

10. In a refrigerator, an above-freezing compartment, and an apparatus within said compartment for making clear ice bodies, said ice body maker comprising: a hollow tubular member having an interior surface defining a passageway; means for forming ice bodies on said tubular member including heat transfer means within said passageway; means, including a heater, for supplying heated air through said passageway and over said heat transfer means; drive means for rotating said tubular member; a scroll-shaped housing for holding a body of water and having an opening, said housing rotatably supporting said tubular member; means defining a collecting space adjacent said housing and in communication with said opening; and control means for periodically initiating said heater and increasing the rotational velocity of said tubular member for effecting the release of said ice bodies therefrom, said housing guiding the released ice bodies outwardly through said opening and into said collecting space.

11. The refrigerator of claim 10 wherein said housing includes an aperture adjacent the bottom of said receptacle and above said body of water, said aperture providing communication between said housing and said receptacle whereby the melt from said ice bodies within said recep-

tacle returns to said body of water for subsequent freezing on said forming means.

12. In an ice making apparatus, an ice forming means comprising: a rotatable tubular member, said tubular member having an outer surface and an inner surface; an ice forming member of high heat conducting material attached to said outer surface, said ice forming member including a pair of oppositely disposed trapezoidal face portions.

13. An ice making apparatus comprising: a housing including means for retaining a body of water; a tubular member supported by said housing; means for forming ice bodies on said tubular member; drive means for rotating said tubular member to move said forming means through said body of water; means for periodically releasing said ice bodies from said tubular member including control means for increasing the speed of said tubular member whereby said ice bodies are forcefully projected outwardly away from said tubular member.

14. An ice making apparatus comprising: a housing including a pair of end portions and a scroll-shaped portion defining an outlet opening, said housing retaining a body of water; a tubular member having an outer surface and supported by said pair of end portions; means for forming

ice bodies on said tubular member; drive means for rotating said tubular member; means for periodically releasing said ice bodies from said tubular member including control means for increasing the speed of said tubular member wherein said ice bodies slide outwardly into contact with said scroll-shaped portion, said scroll-shaped portion guiding said ice bodies toward said opening whereupon reaching said opening said ice bodies are disengaged from said tubular member.

15. The ice making apparatus of claim 14 wherein said tubular member includes a plurality of ice forming members of high heat conducting material attached to said outer surface, each of said forming members including a pair of oppositely disposed trapezoidal face portions.

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