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(54) **METHOD AND APPARATUS FOR ICE HARVESTING**

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(73) Assignee: **PEPSICO, INC.**, Purchase, NY (US)

(21) Appl. No.: **13/618,799**

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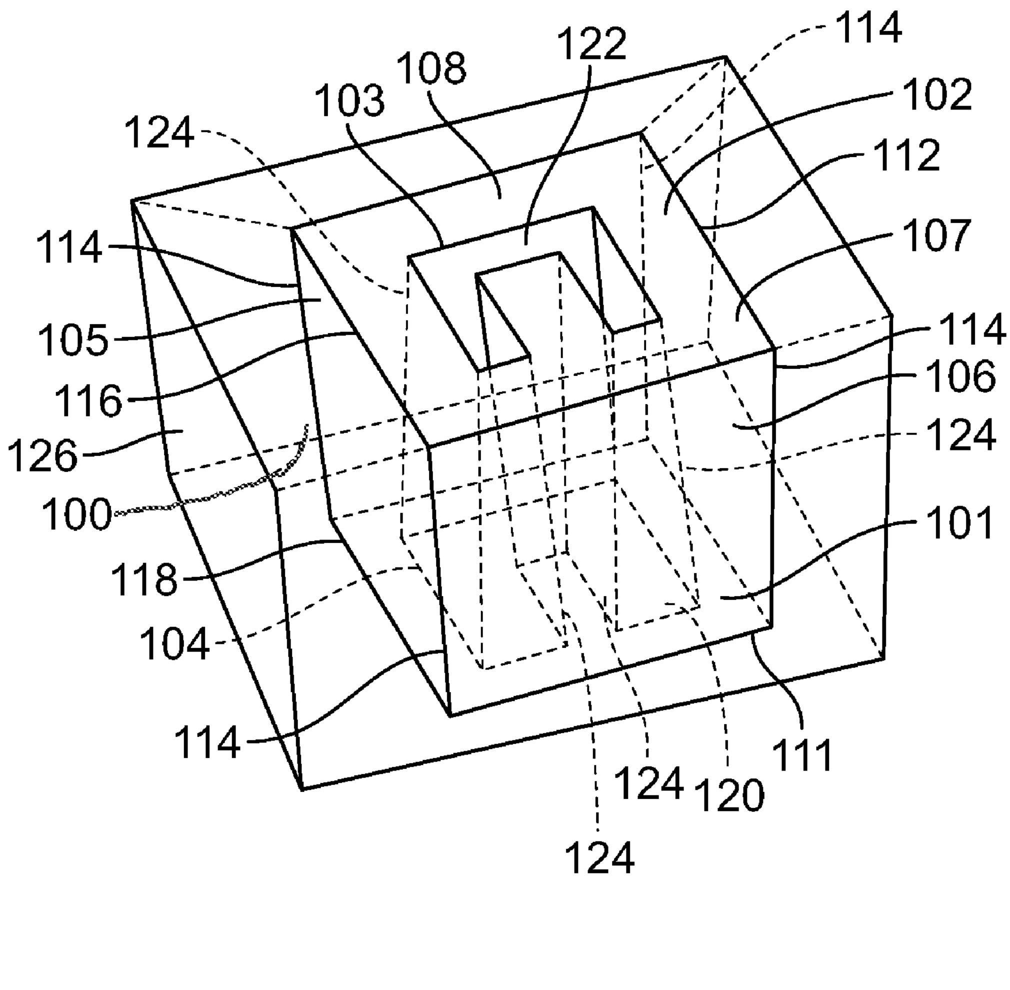
Publication Classification

(51) **Int. Cl.**
F25C 1/22 (2006.01)

(52) **U.S. Cl.**
CPC ***F25C 1/22*** (2013.01)
USPC **62/66**; 62/340

(57) **ABSTRACT**

A mold defines a first volume for an ice cube, the mold comprising a bottom face having an inner perimeter and side faces. Each side face has an inner perimeter, top edge, and bottom edge. The top edge of each side face may be longer than the bottom edge. Each side face may extend inward from the top edge to the bottom edge. The mold may comprise a three-dimensional shape within the first volume, the three-dimensional shape comprising a second volume. The second volume may be defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge of the three-dimensional shape. The bulge may extend upwardly and taper between the bottom outer perimeter and the top outer perimeter. The mold may further define a third volume between the first and second volumes, with the mold configured to receive water within the third volume.



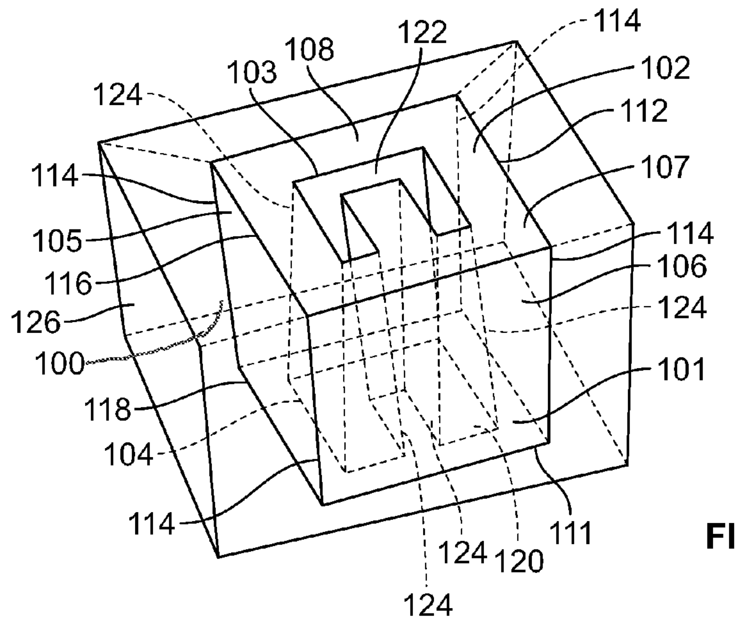

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FIG. 1A

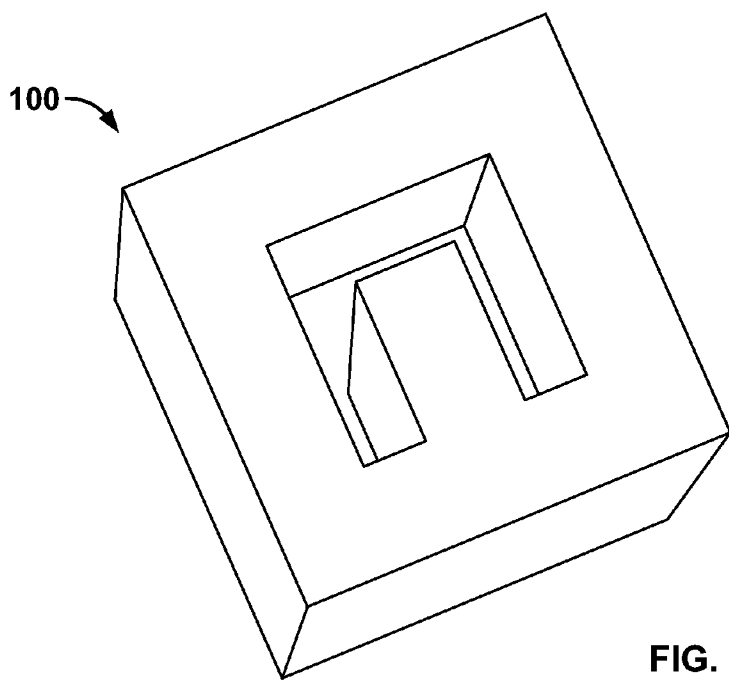

100

FIG. 1B

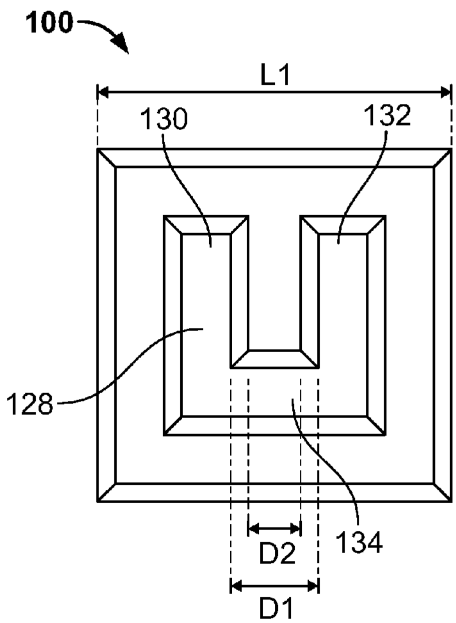


FIG. 1C

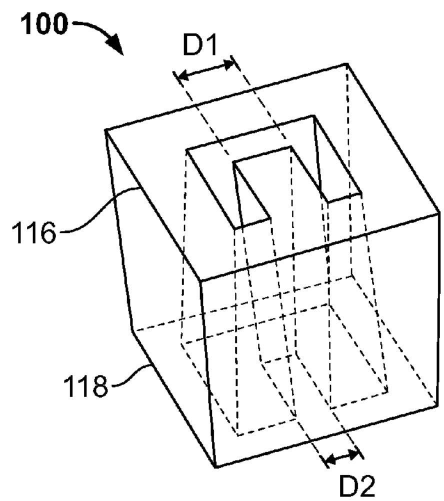


FIG. 1D

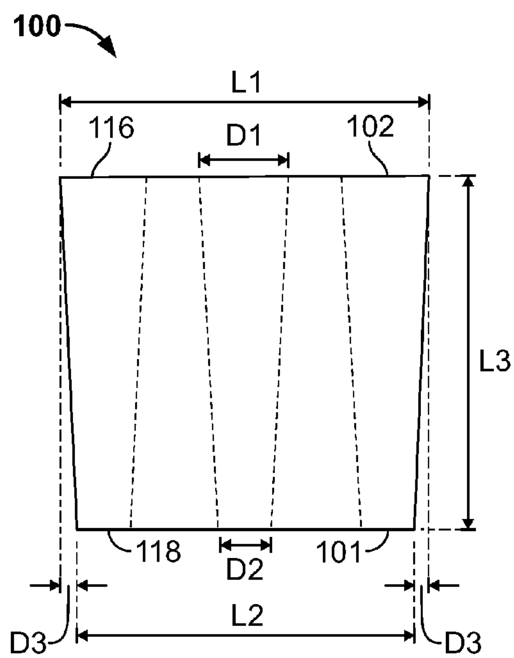


FIG. 1E

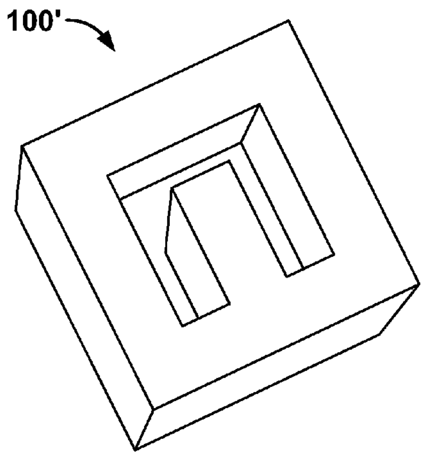


FIG. 1F

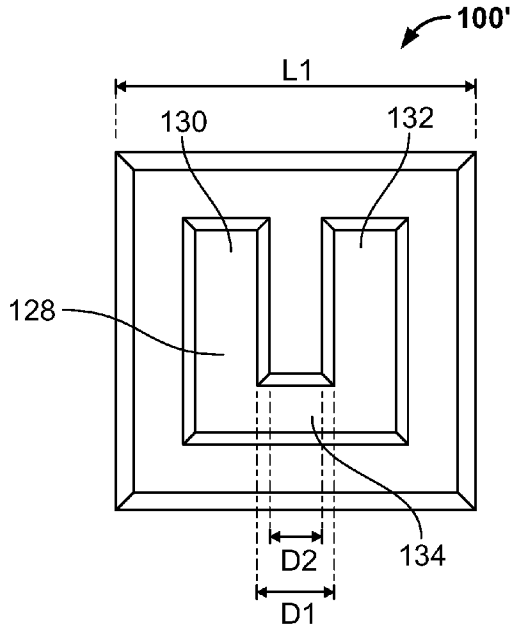


FIG. 1G

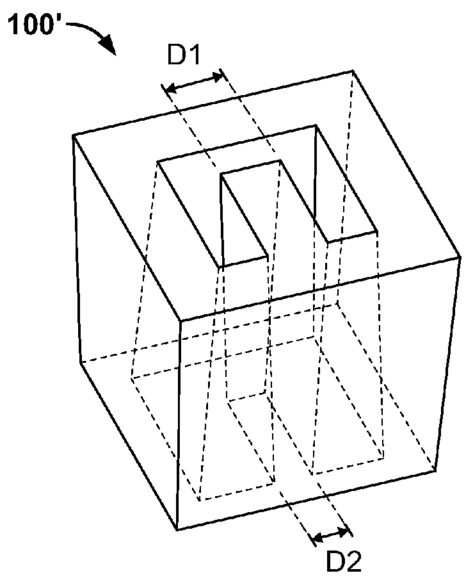


FIG. 1H

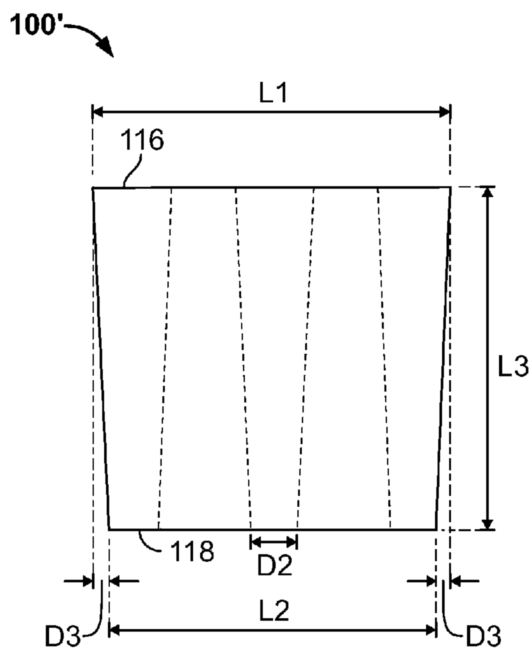


FIG. 1I

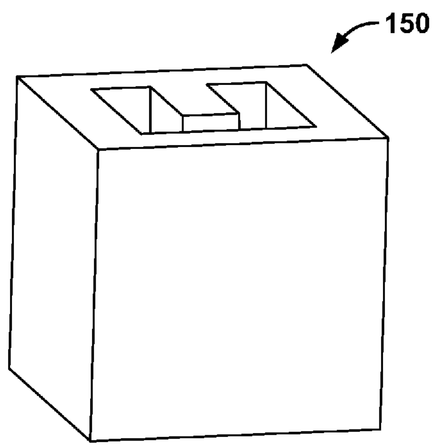


FIG. 1J

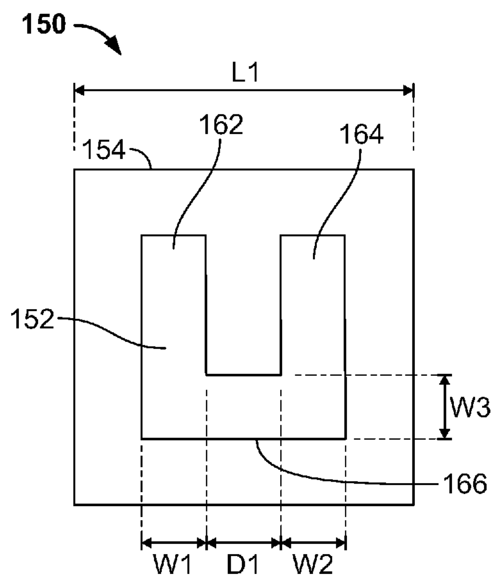


FIG. 1K

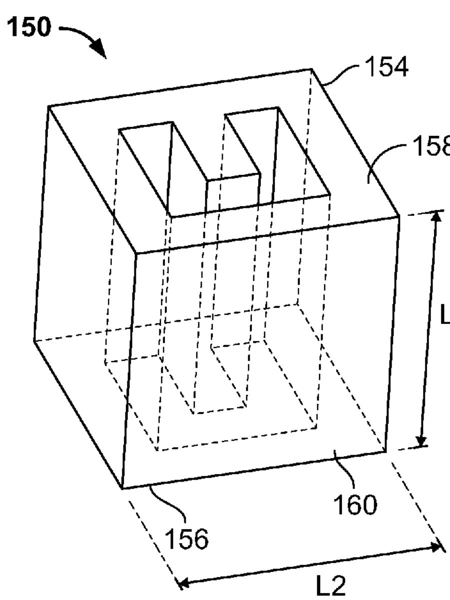


FIG. 1L

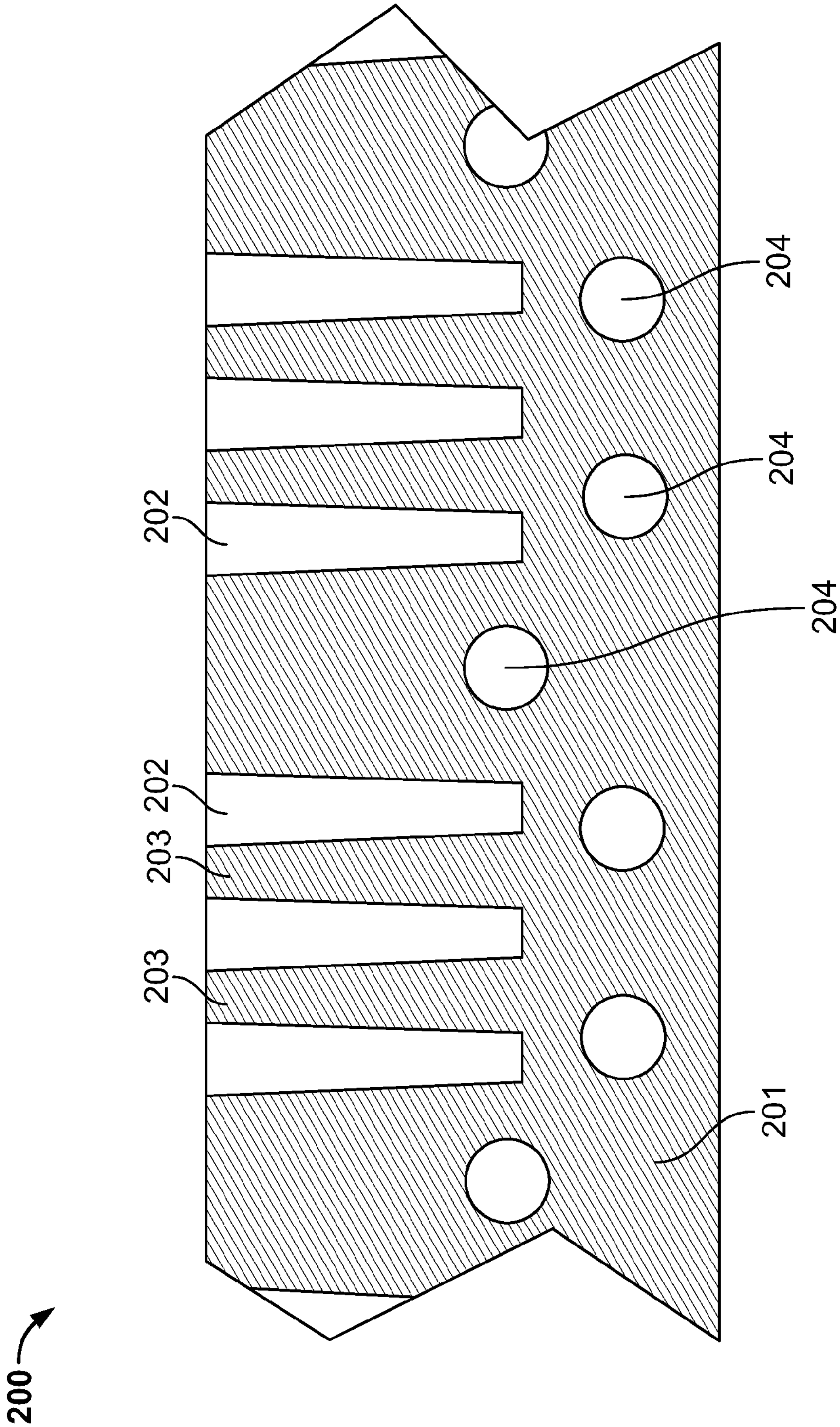


FIG. 2

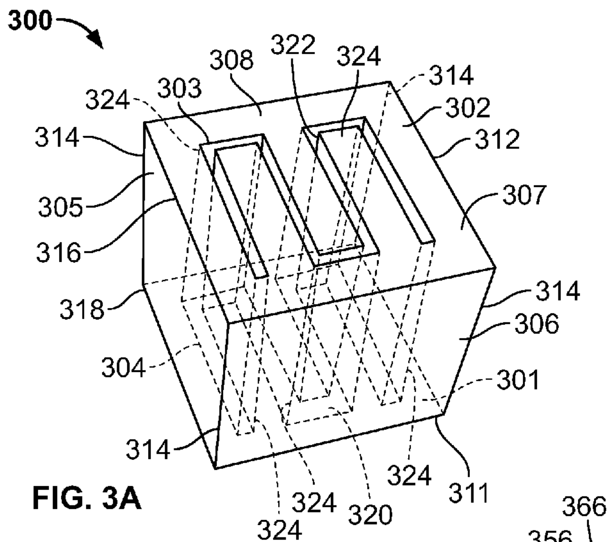


FIG. 3A

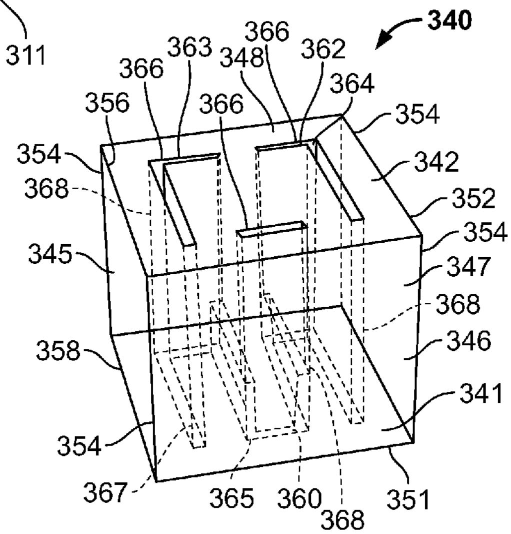


FIG. 3B

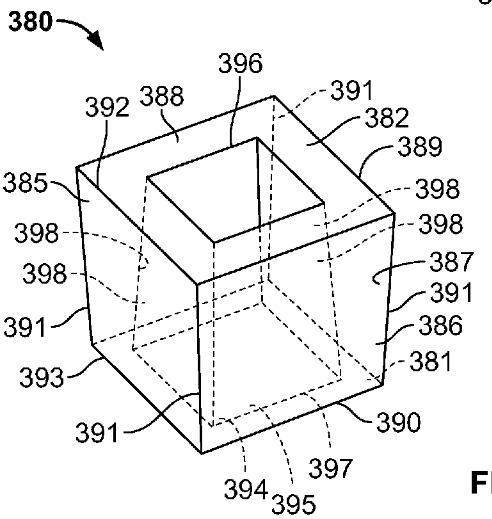


FIG. 3C

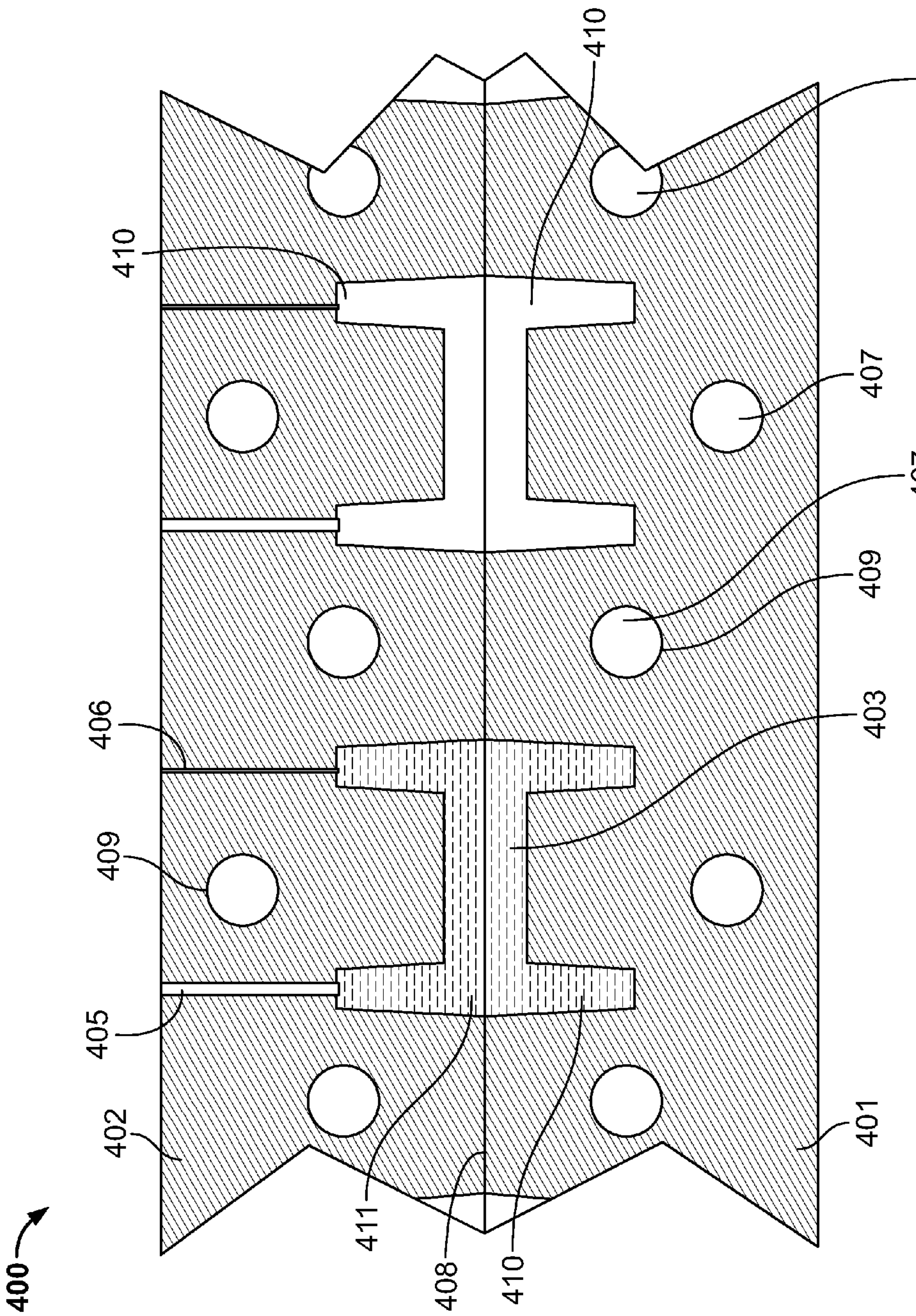


FIG. 4

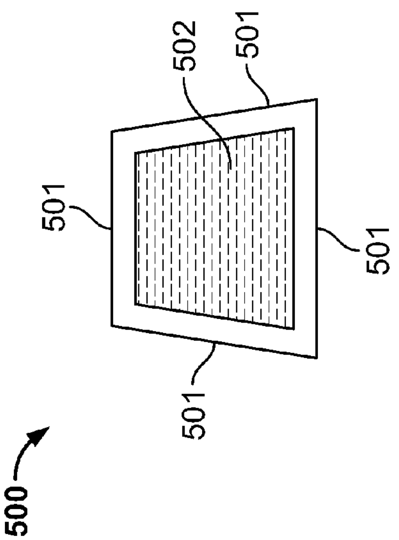


FIG. 5

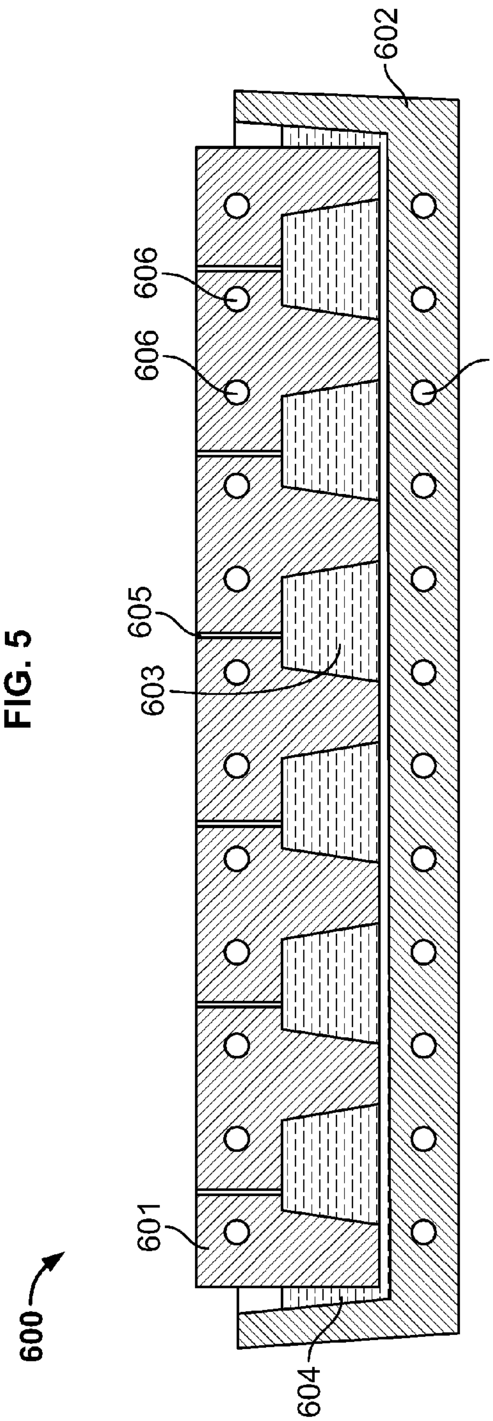


FIG. 6

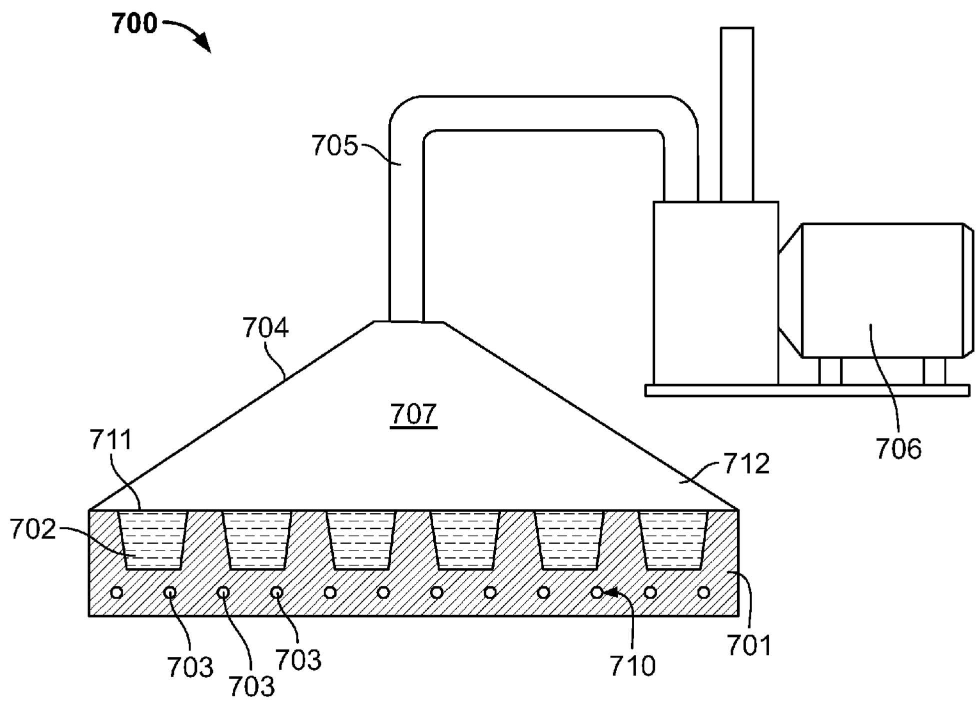
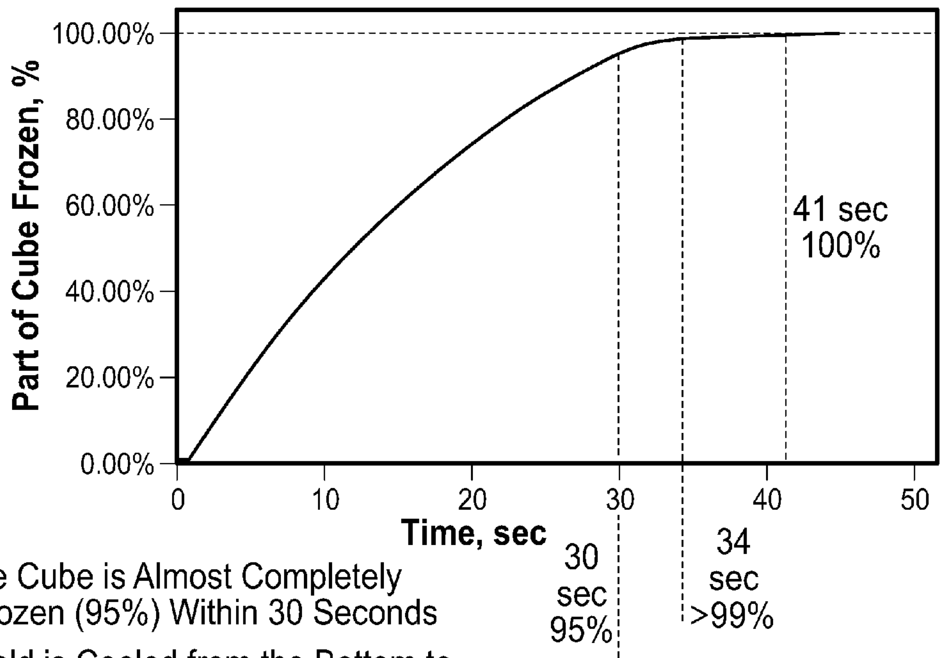


FIG. 7



• Ice Cube is Almost Completely Frozen (95%) Within 30 Seconds

• Mold is Cooled from the Bottom to -30 °C

FIG. 8A

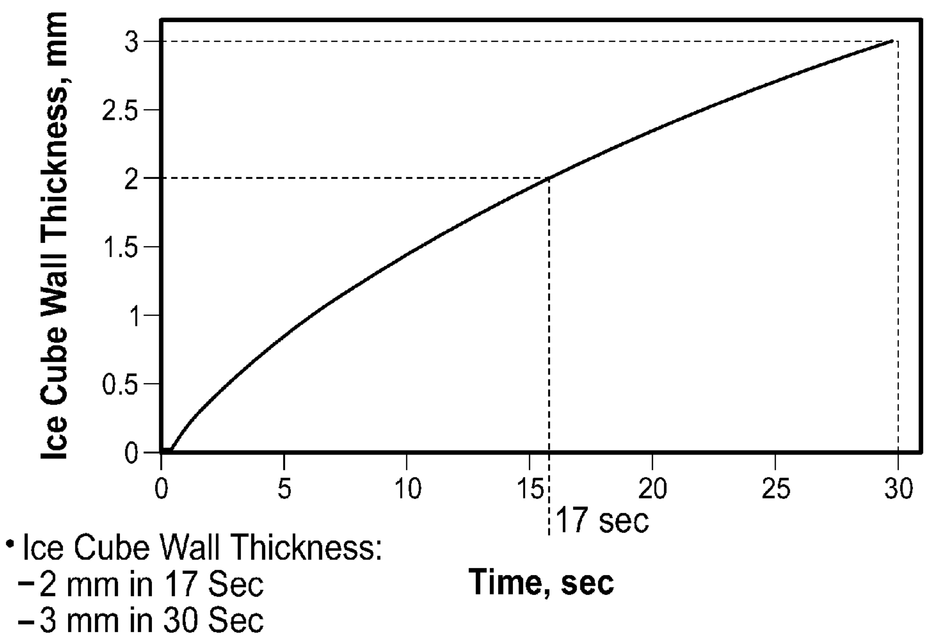

Ice Cube Wall Thickness, mm
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
17 sec
Time, sec
• Ice Cube Wall Thickness:
−2 mm in 17 Sec
−3 mm in 30 Sec

FIG. 8B

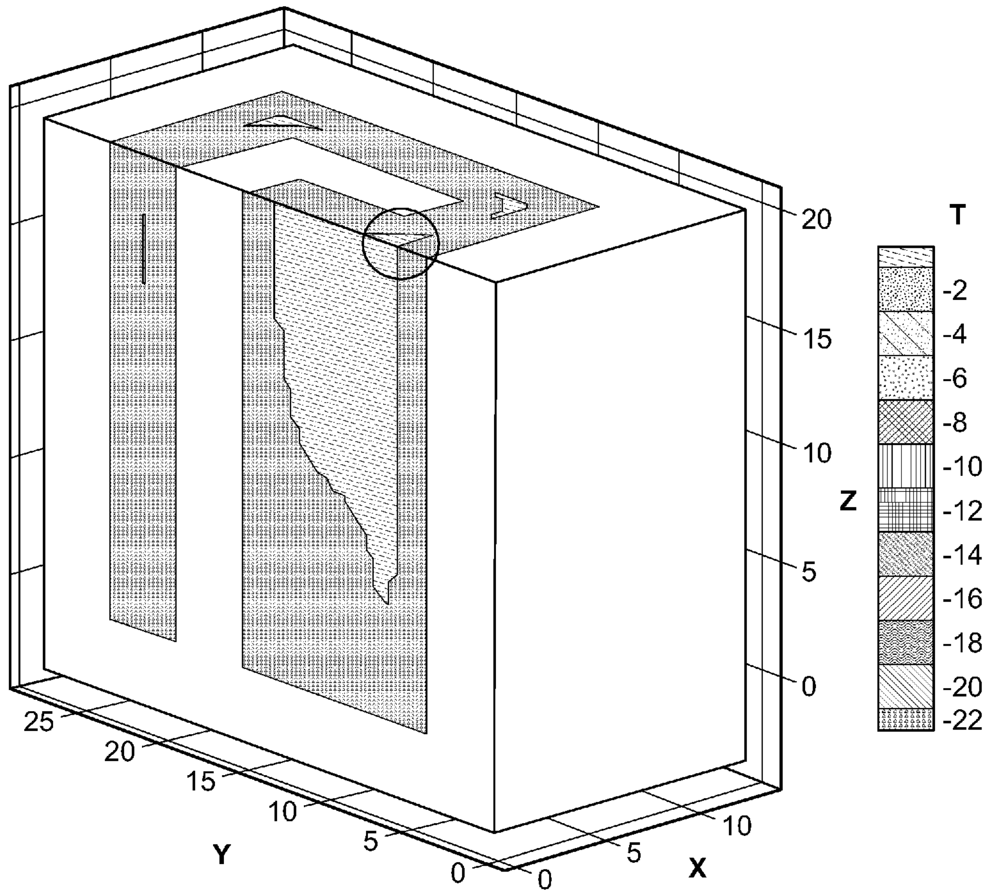


FIG. 9A

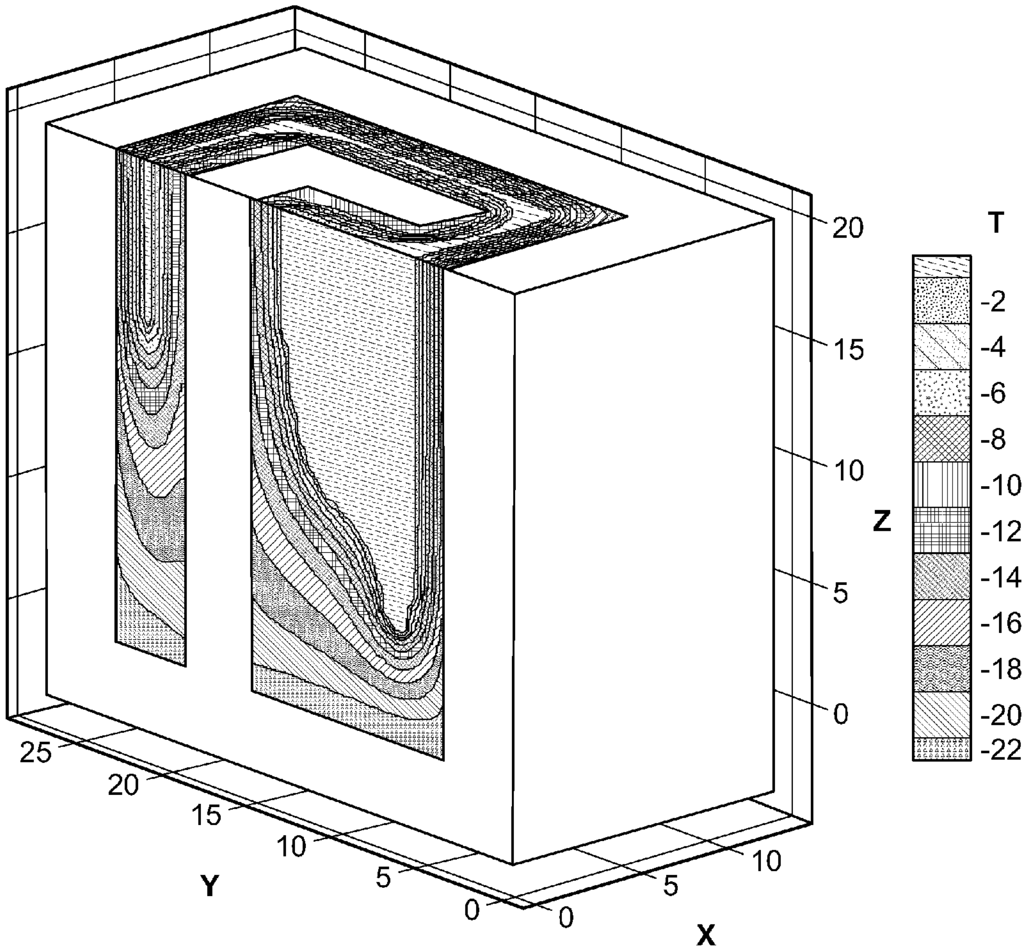


FIG. 9B

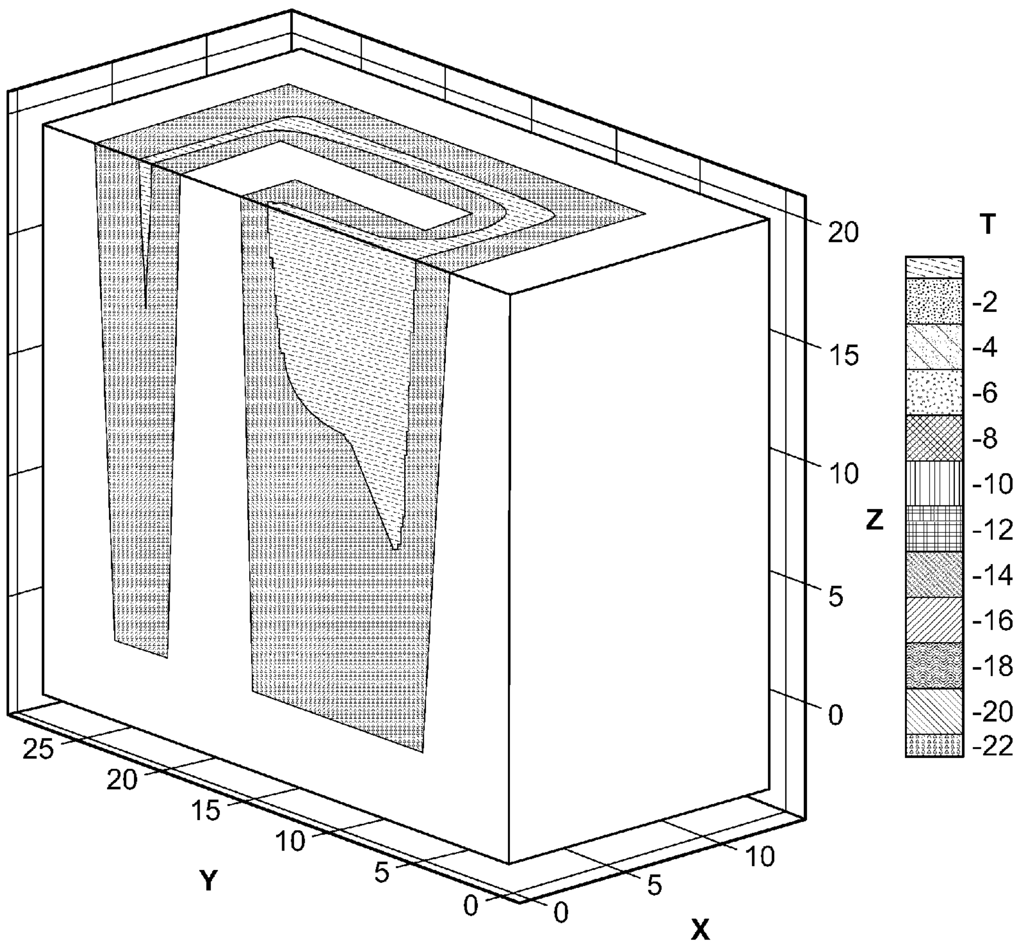


FIG. 9C

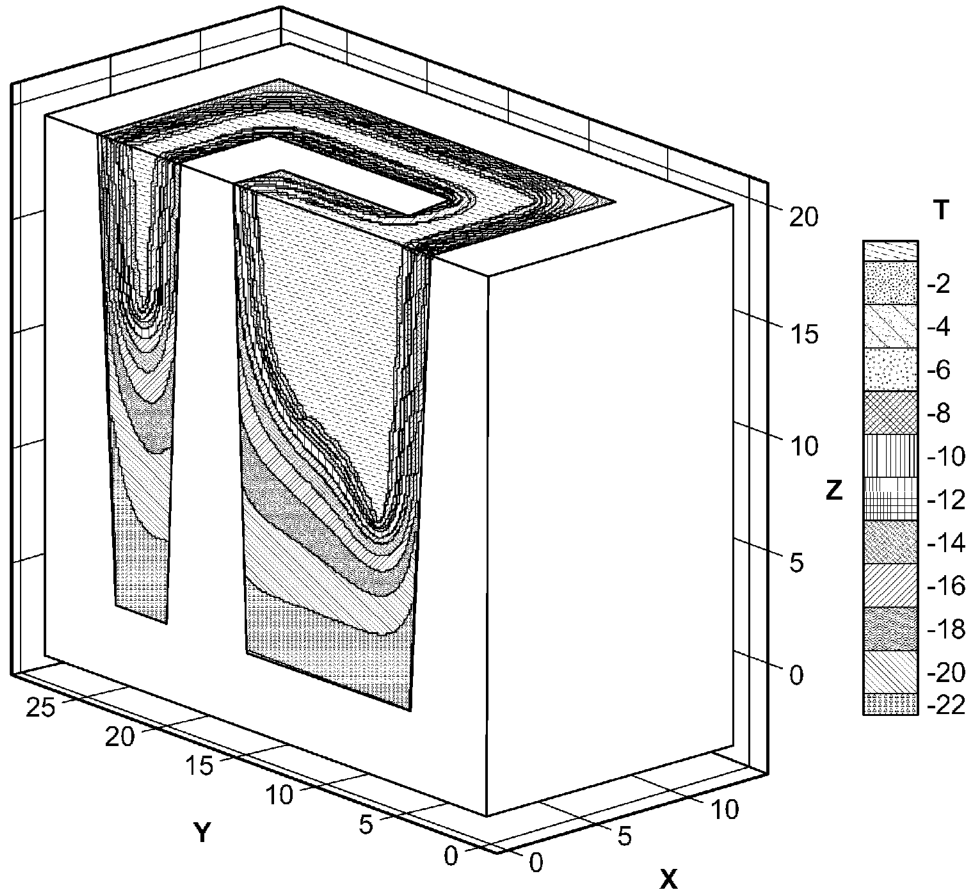


FIG. 9D

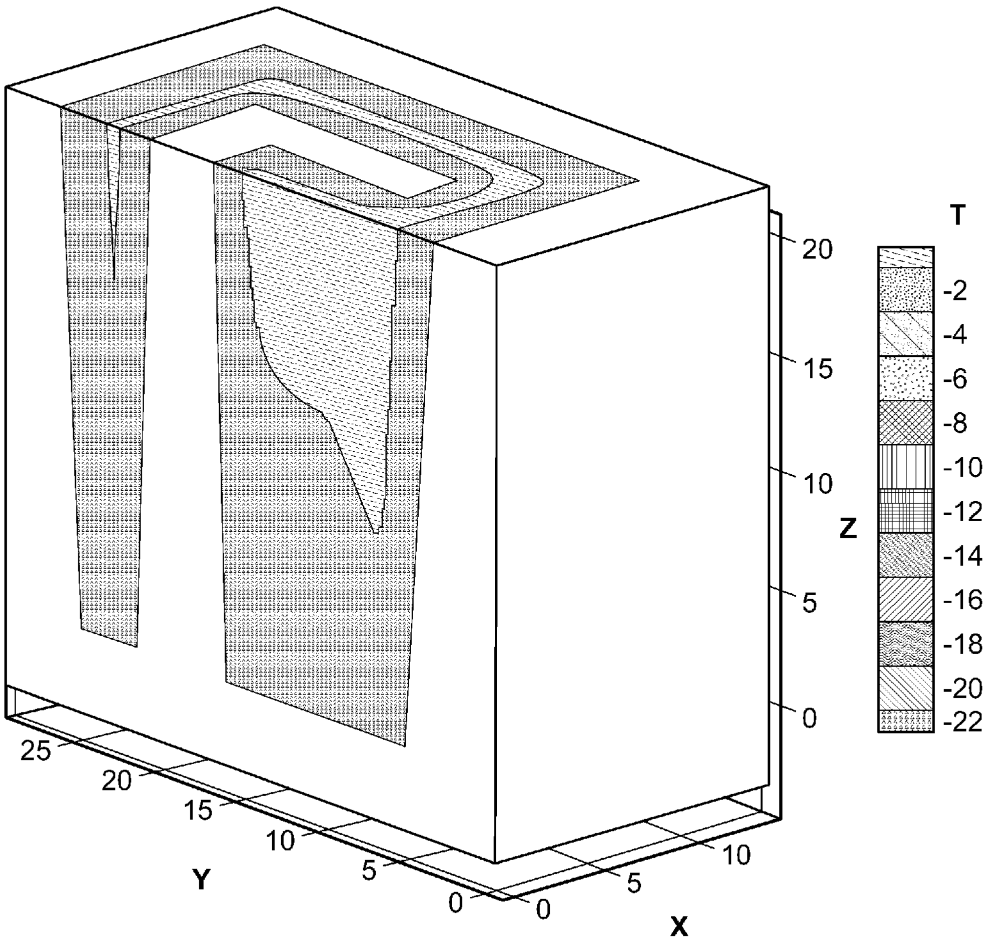


FIG. 9E

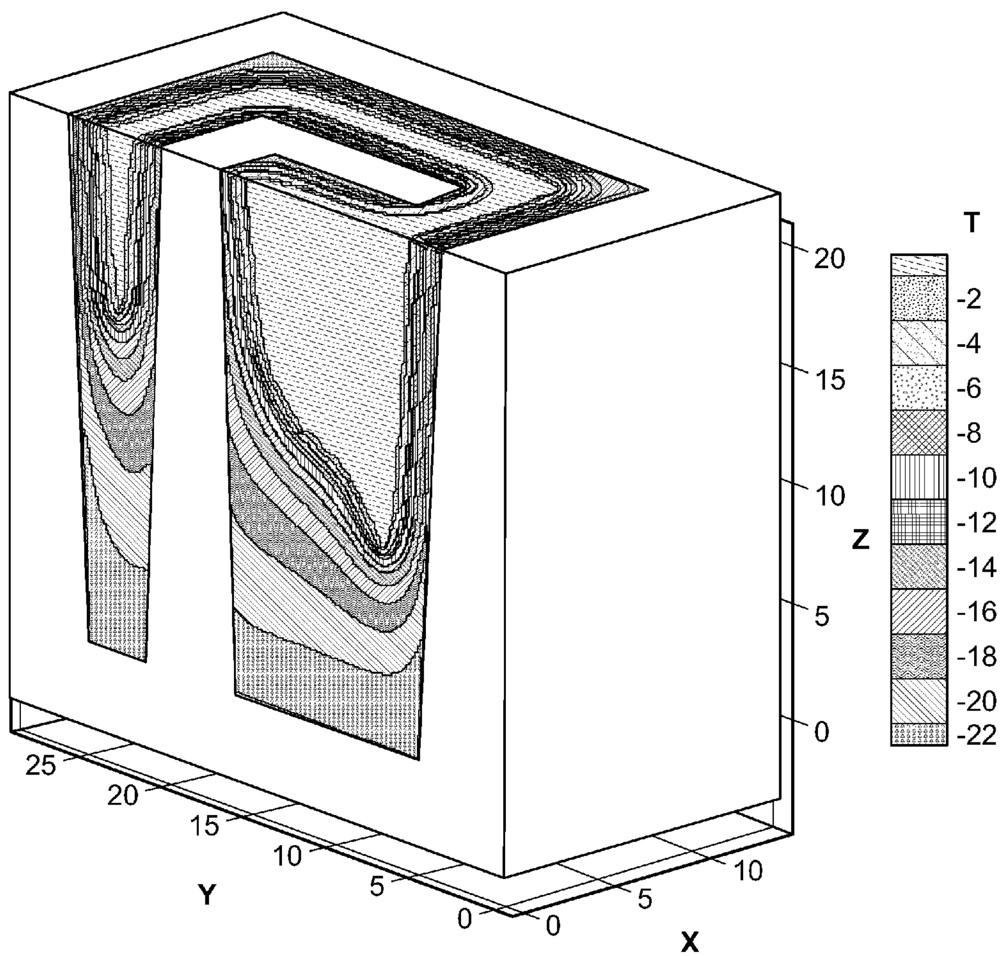


FIG. 9F

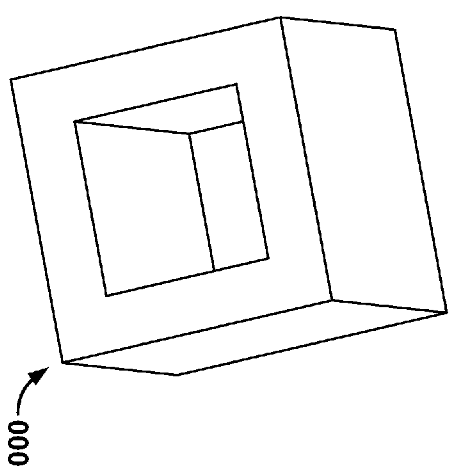


FIG. 10A

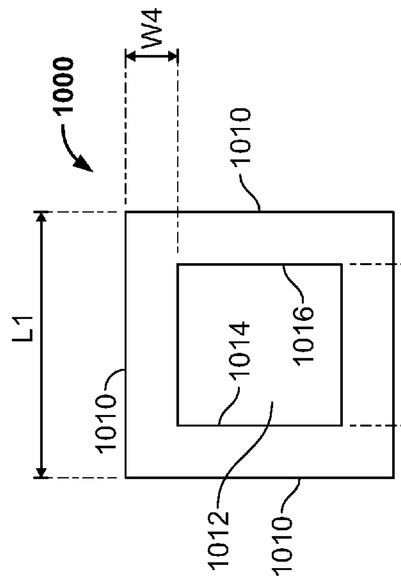


FIG. 10B

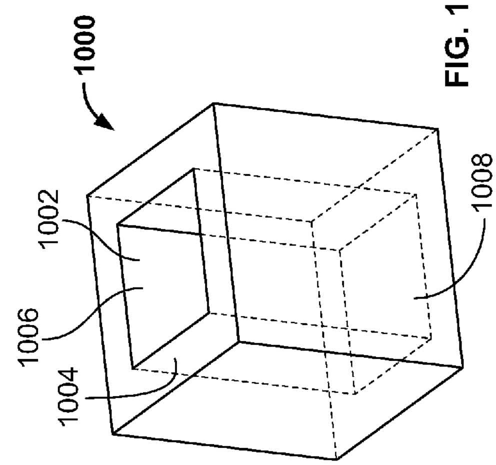


FIG. 10C

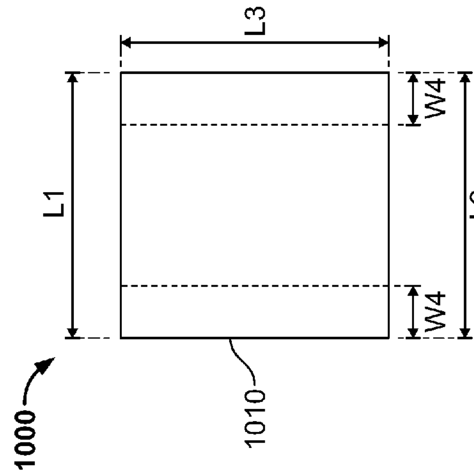


FIG. 10D

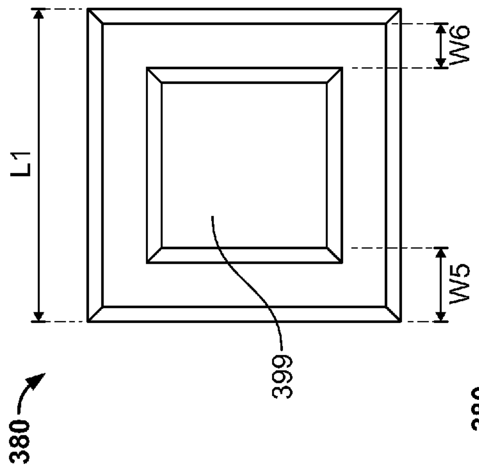


FIG. 11B

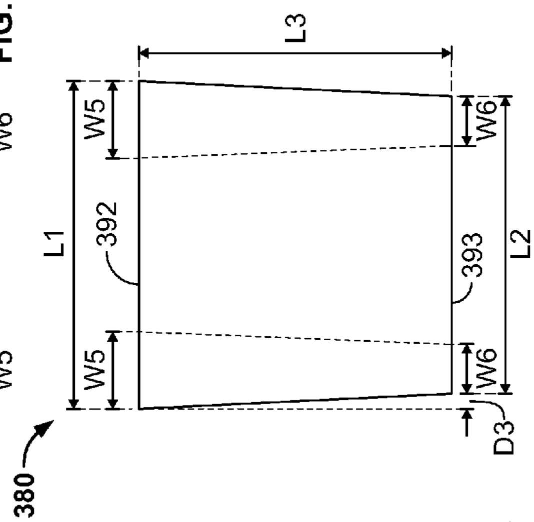


FIG. 11D

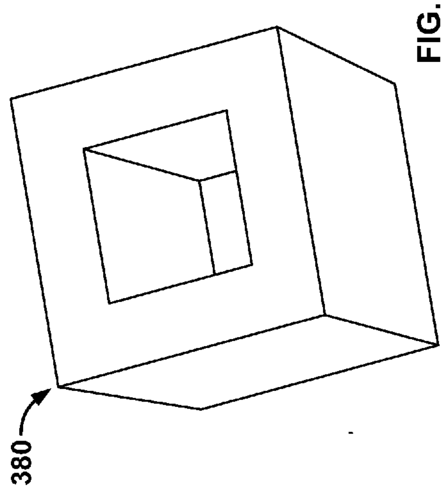


FIG. 11A

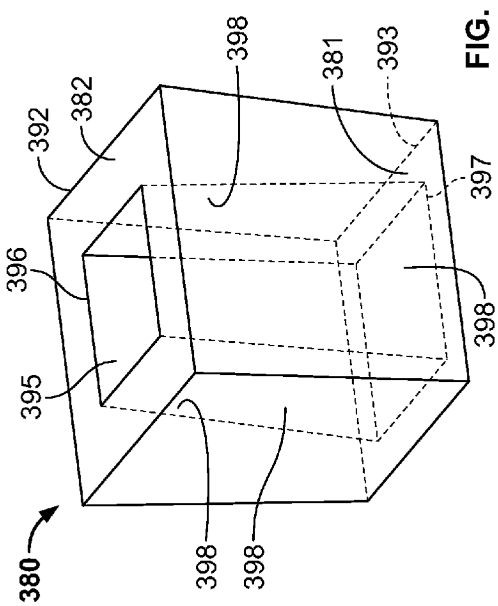


FIG. 11C

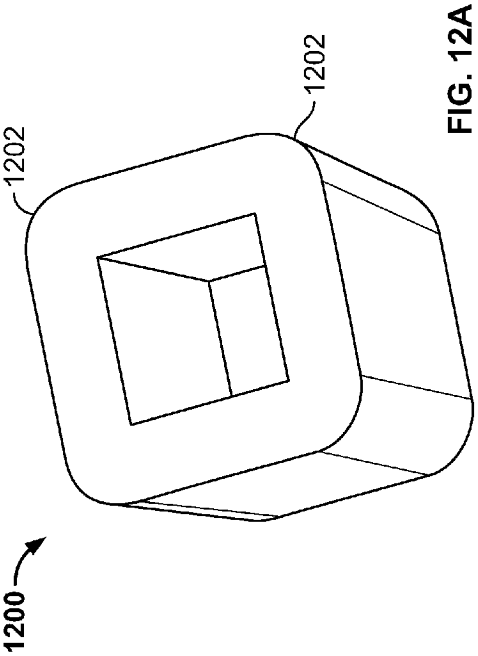


FIG. 12A

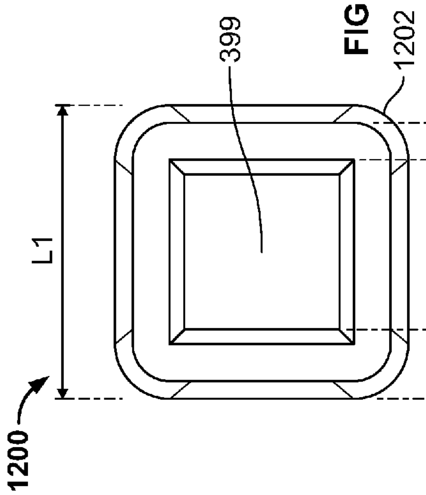


FIG. 12B

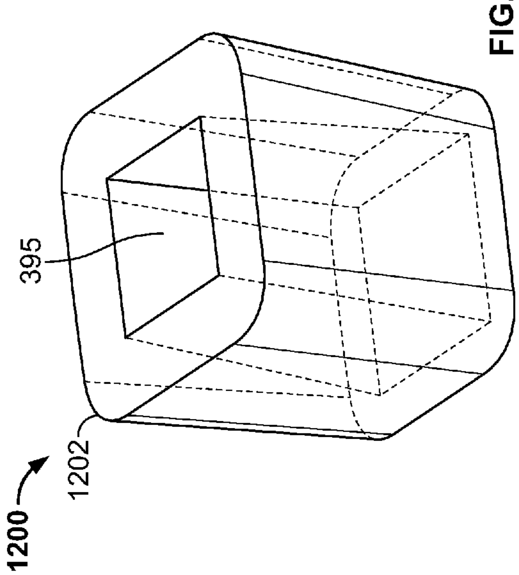


FIG. 12C

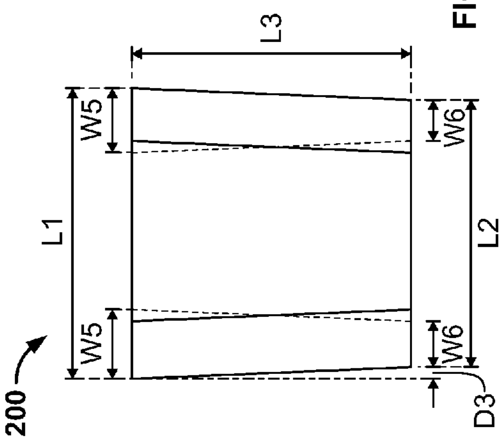


FIG. 12D

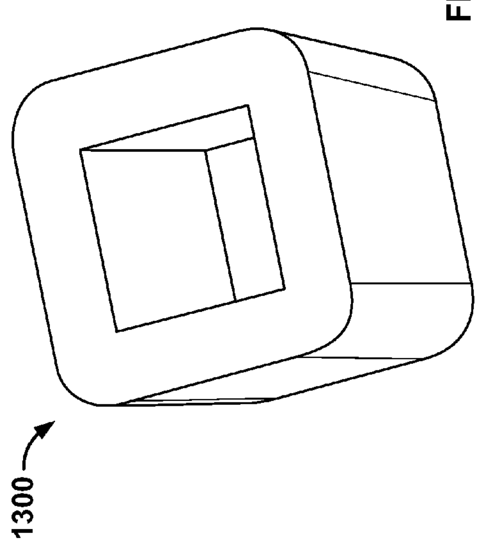


FIG. 13A

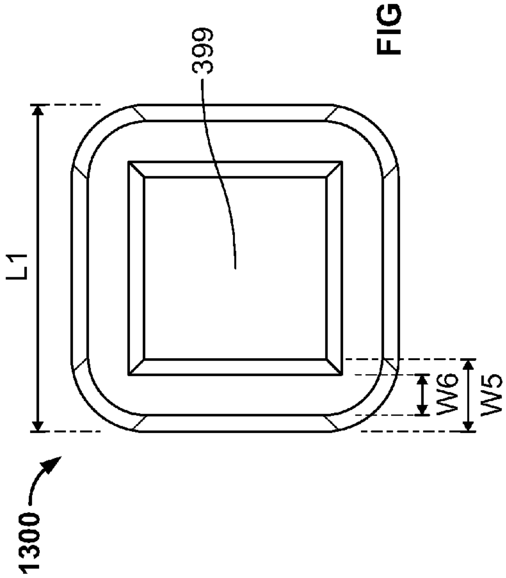


FIG. 13B

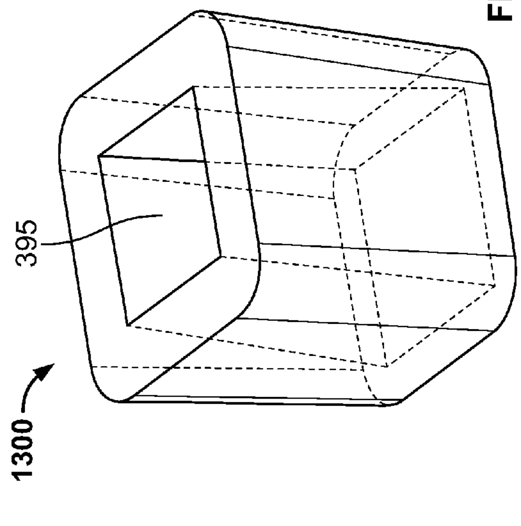


FIG. 13C

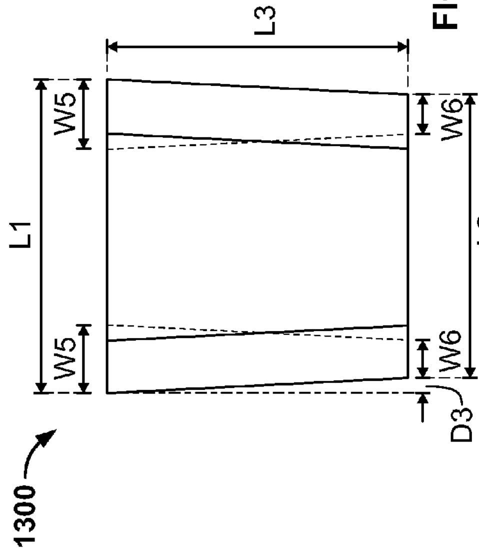
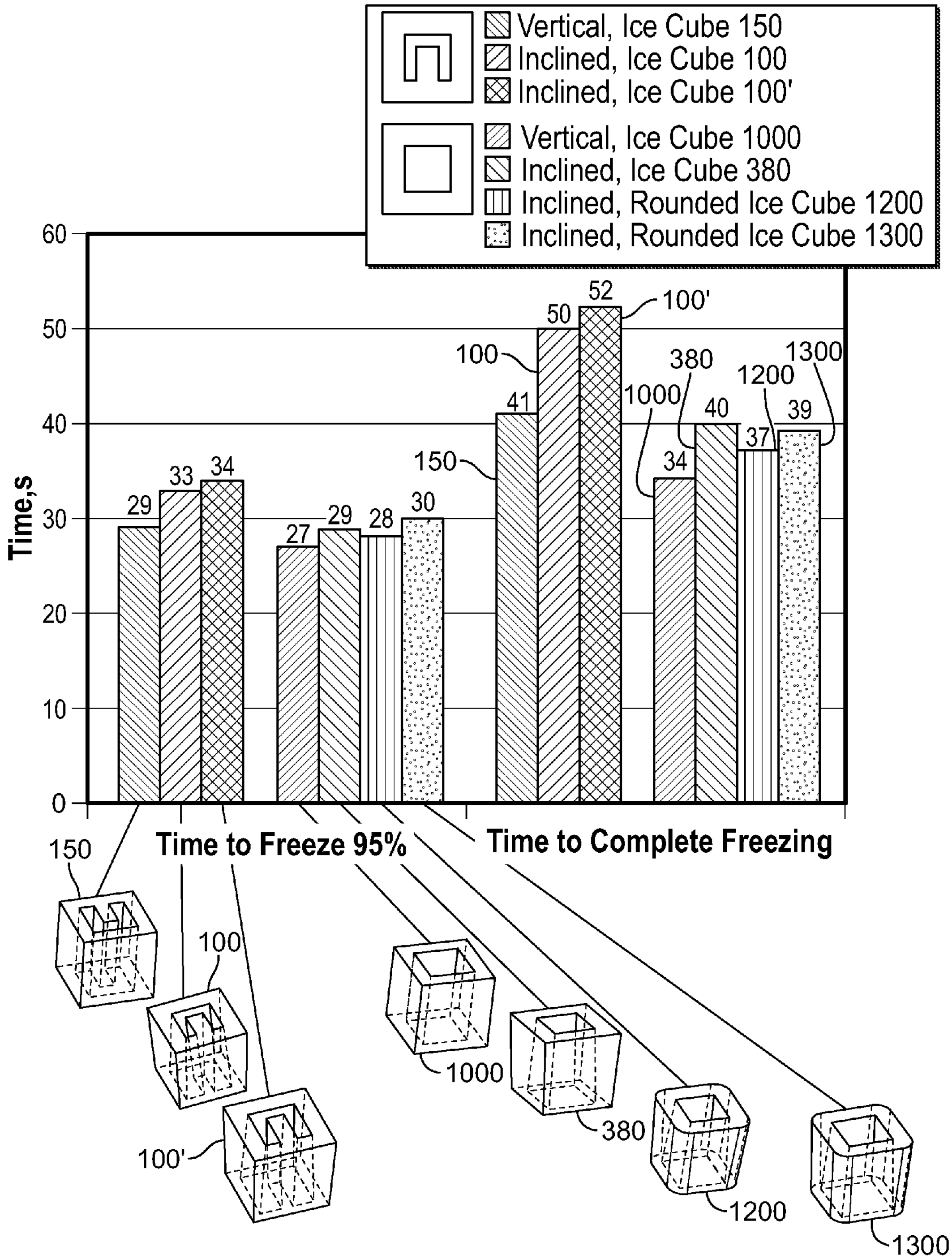


FIG. 13D


Vertical, Ice Cube 150
Inclined, Ice Cube 100
Inclined, Ice Cube 100'
Vertical, Ice Cube 1000
Inclined, Ice Cube 380
Inclined, Rounded Ice Cube 1200
Inclined, Rounded Ice Cube 1300
Time,s
60
50
40
30
20
10
0
29
33
34
27
29
28
30
41
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39
150
100
100'
1000
380
1200
1300
Time to Freeze 95%
Time to Complete Freezing

FIG. 14

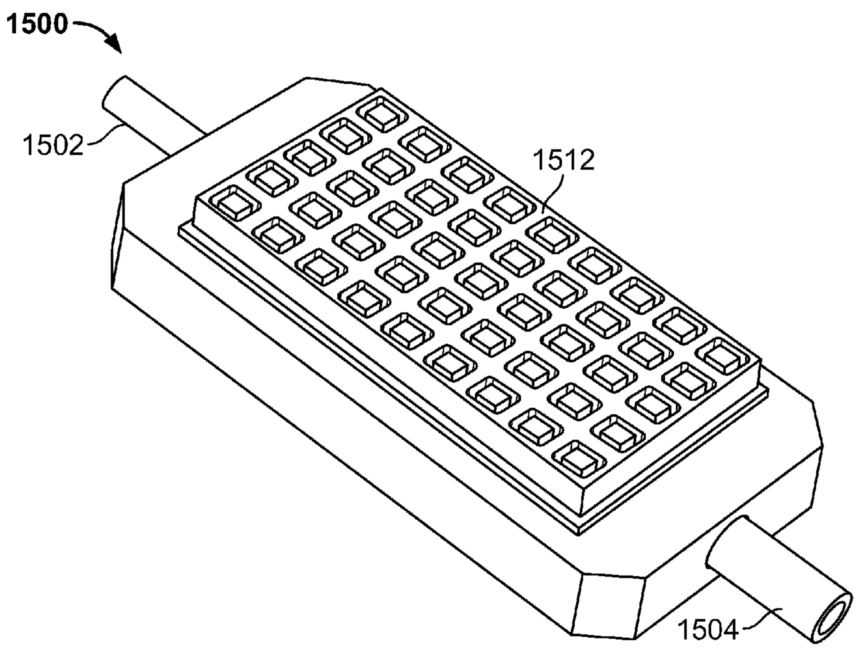


FIG. 15A

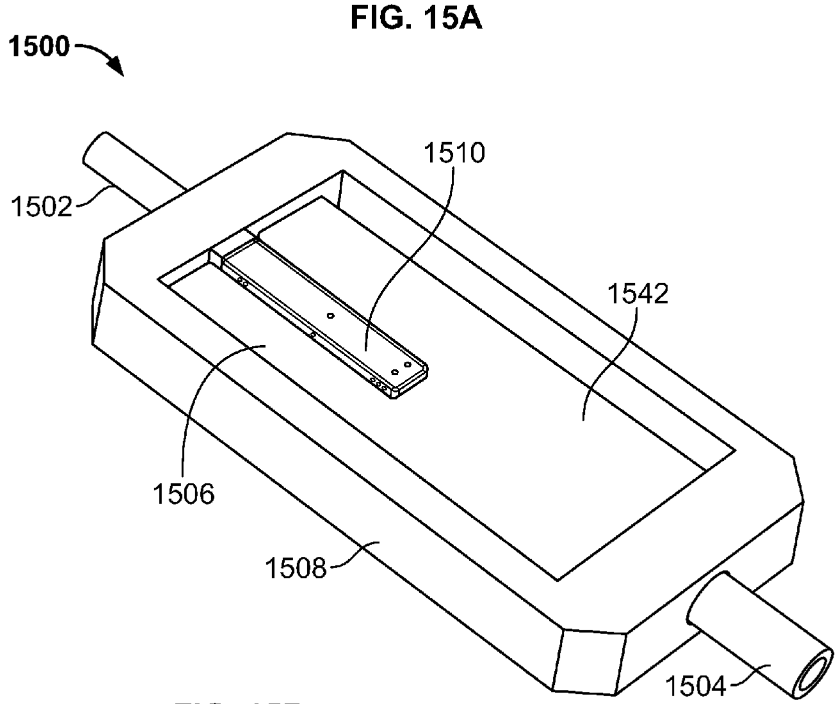


FIG. 15B

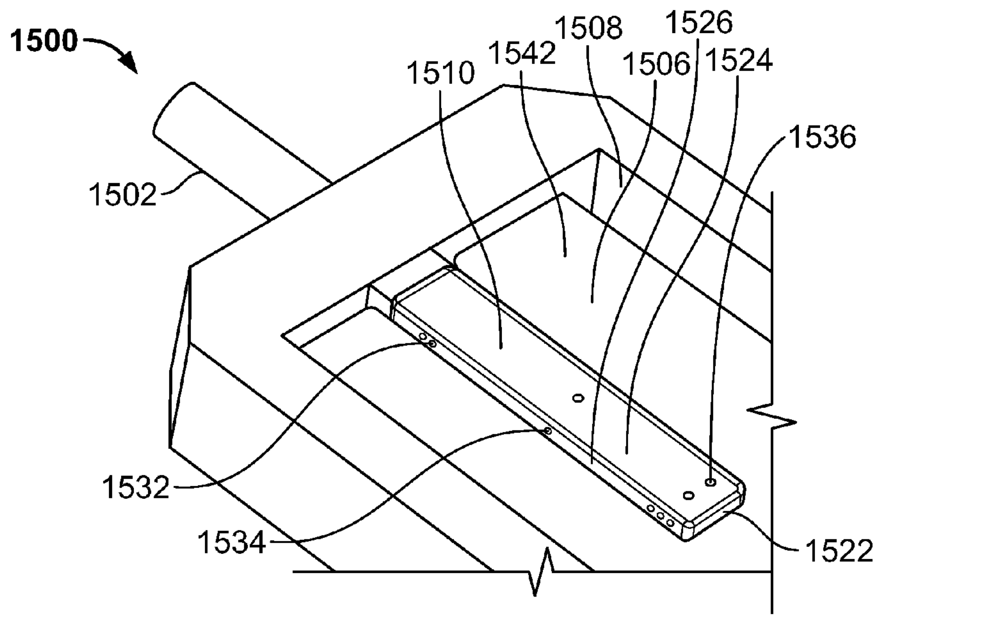


FIG. 15C

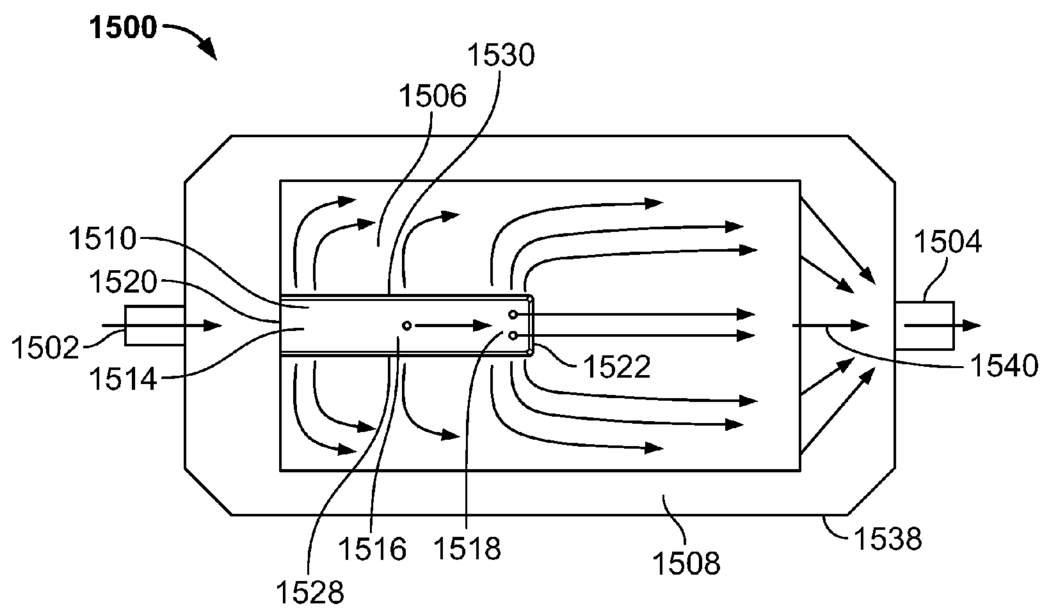


FIG. 15D

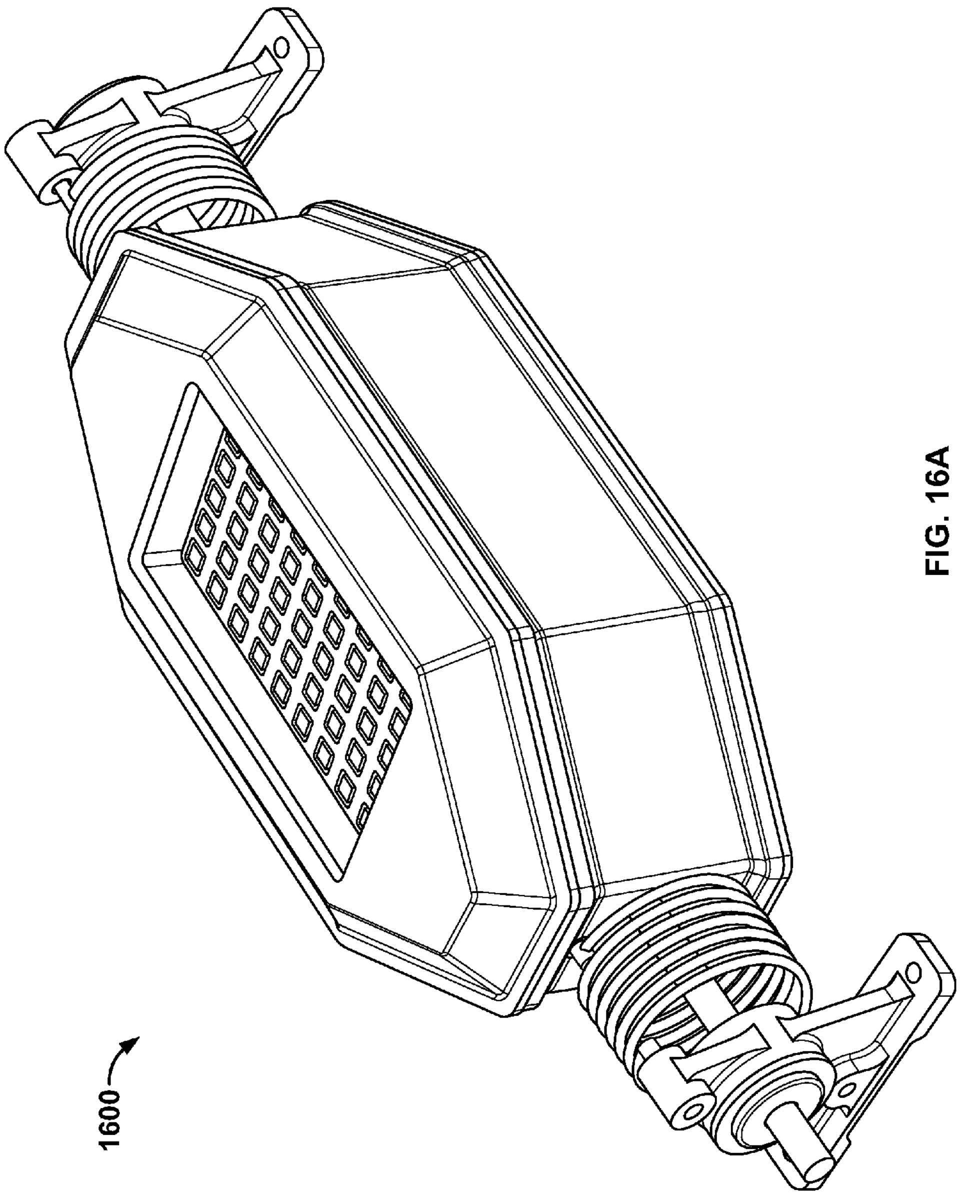
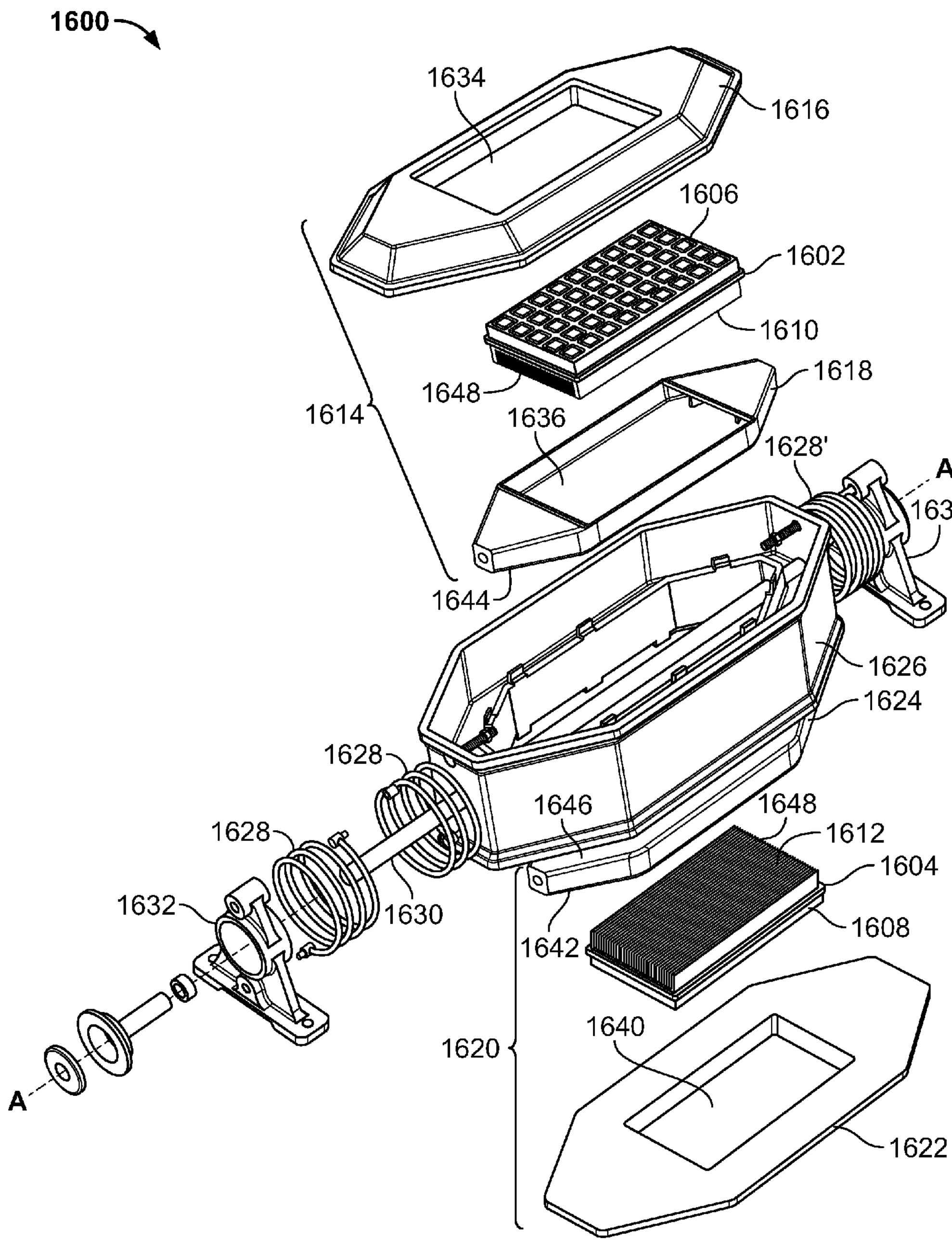


FIG. 16A


1600
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1628'
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1608
1640
1620
A
1622

FIG. 16B

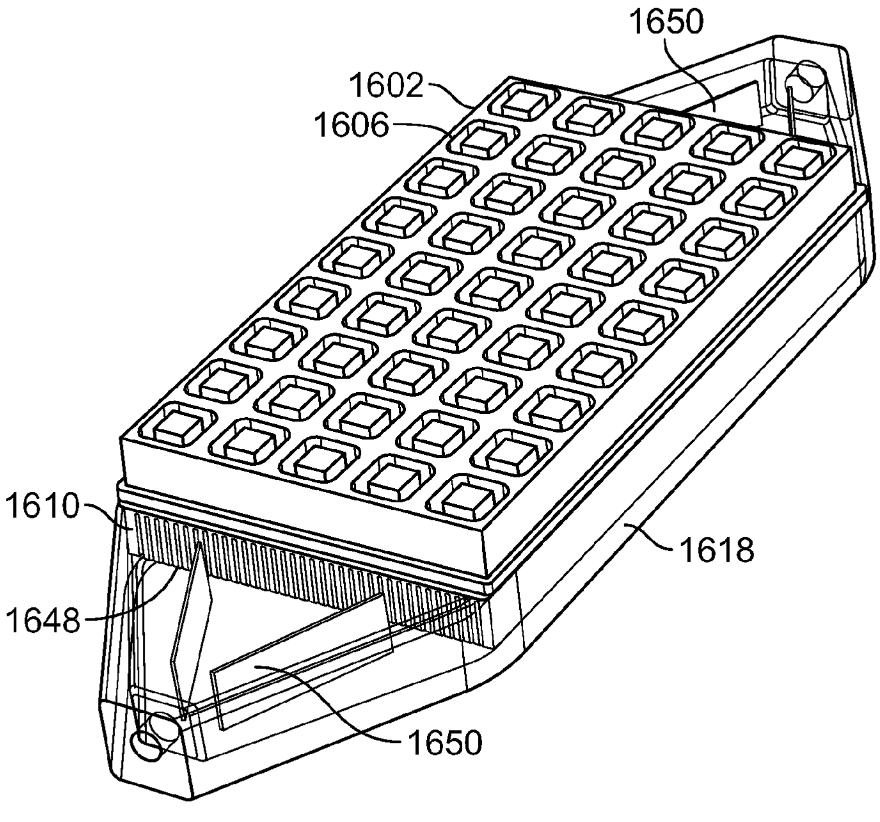

FIG. 17A

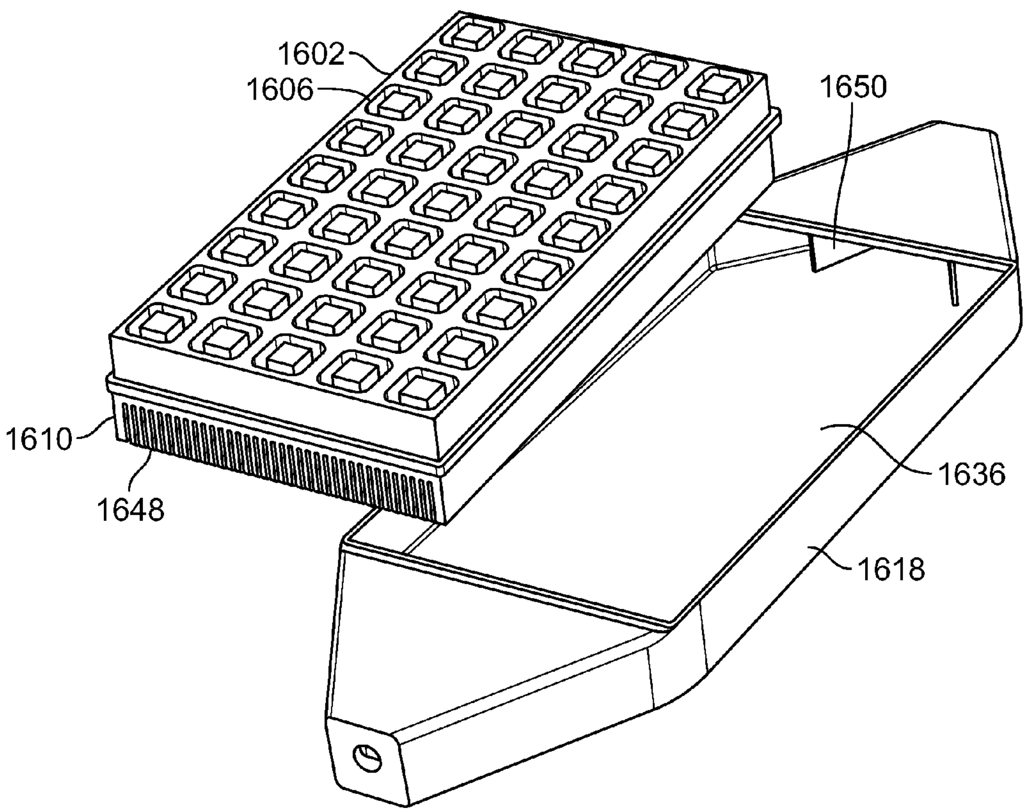

FIG. 17B

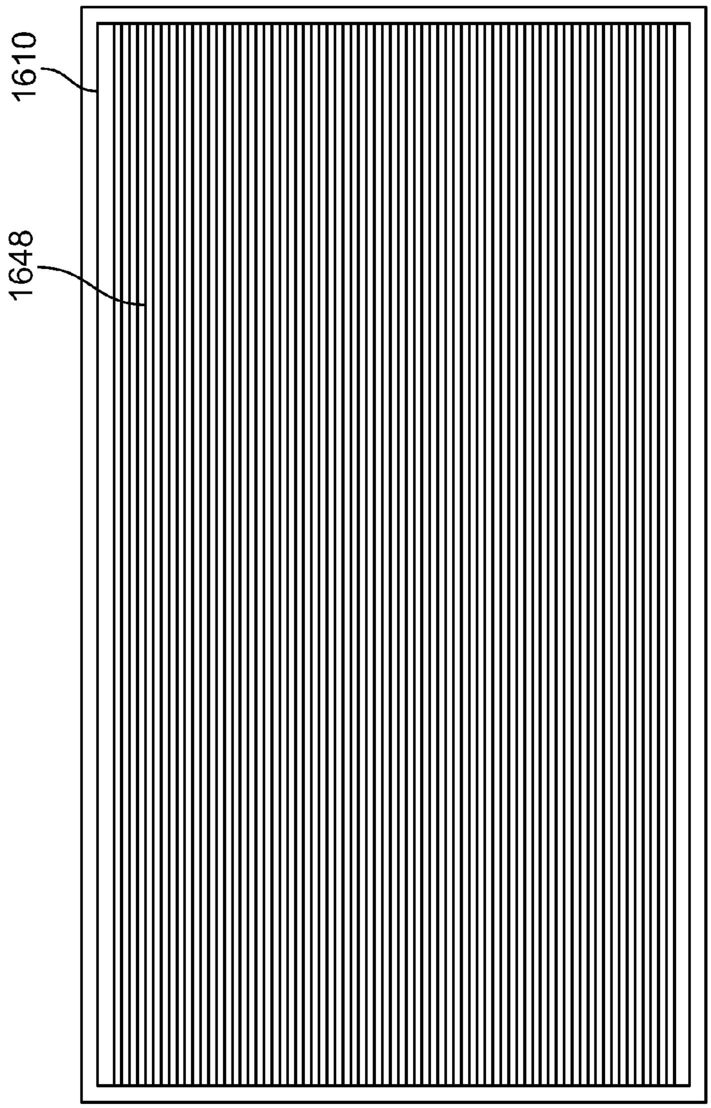

FIG. 18B

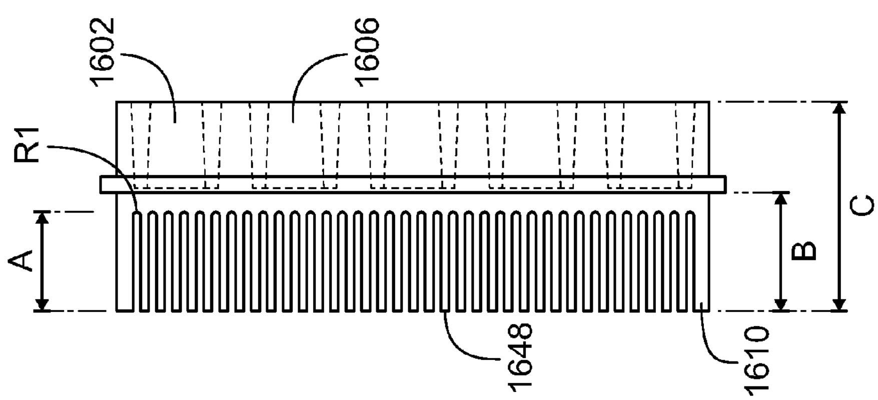

FIG. 18A

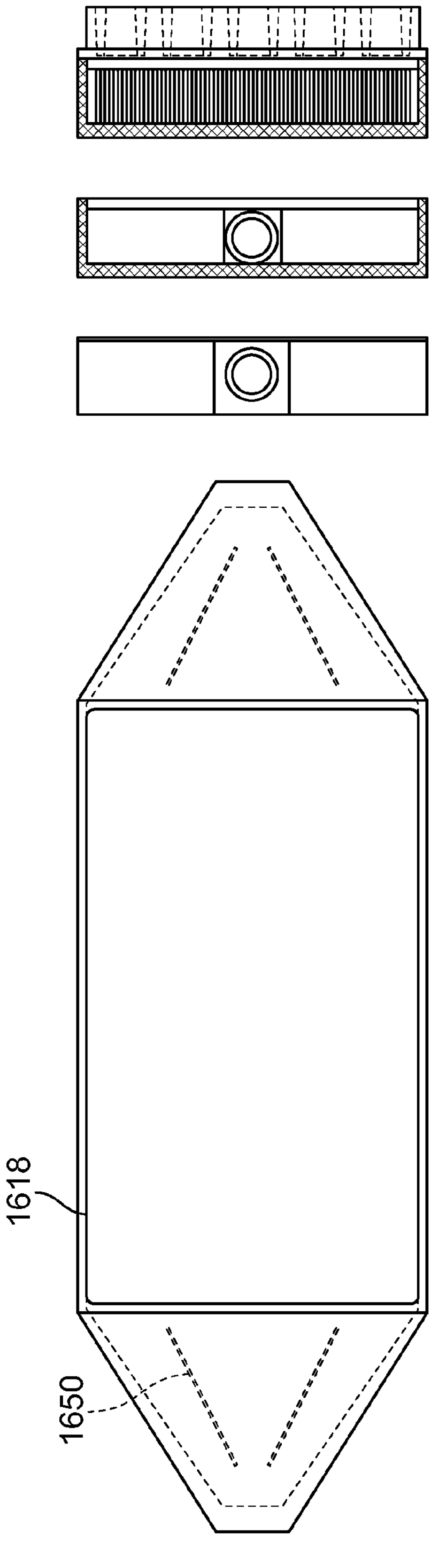

FIG. 19

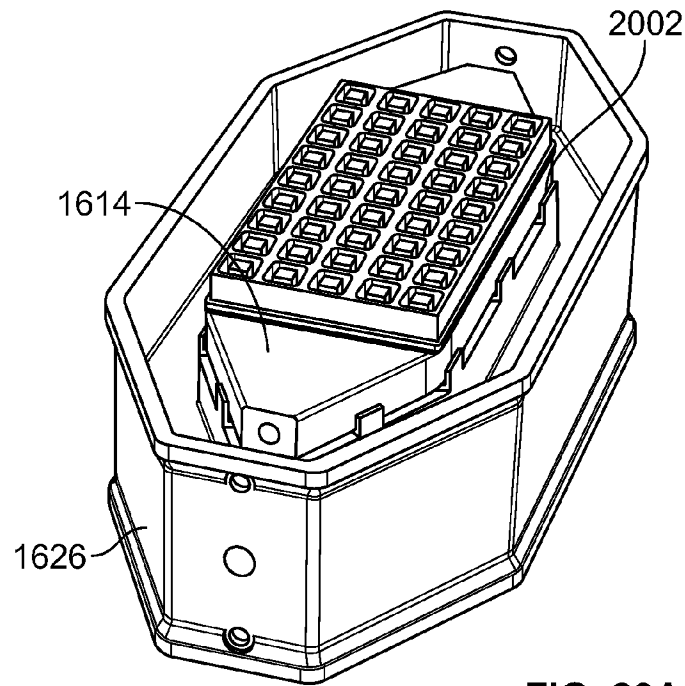

FIG. 20A

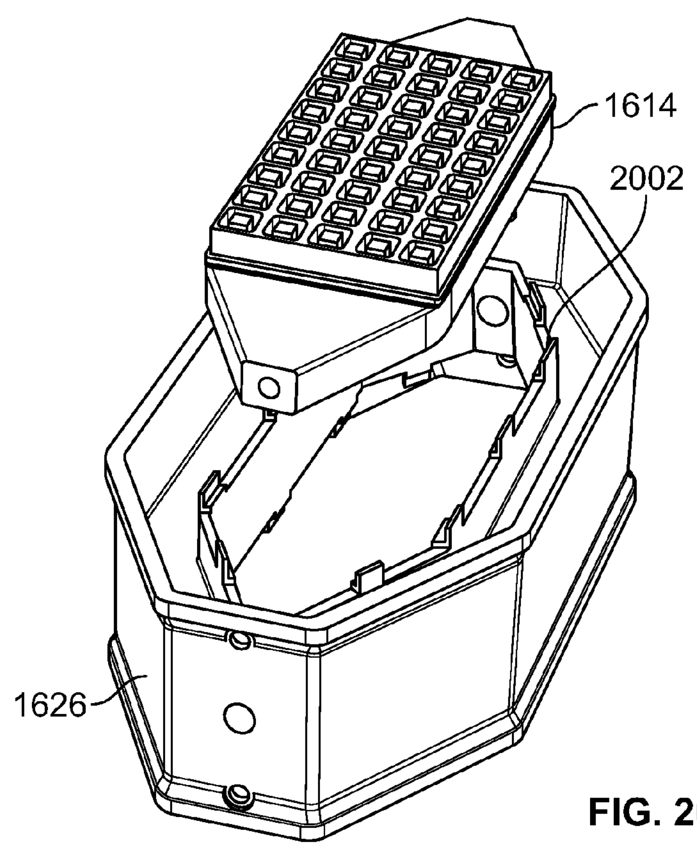

FIG. 20B

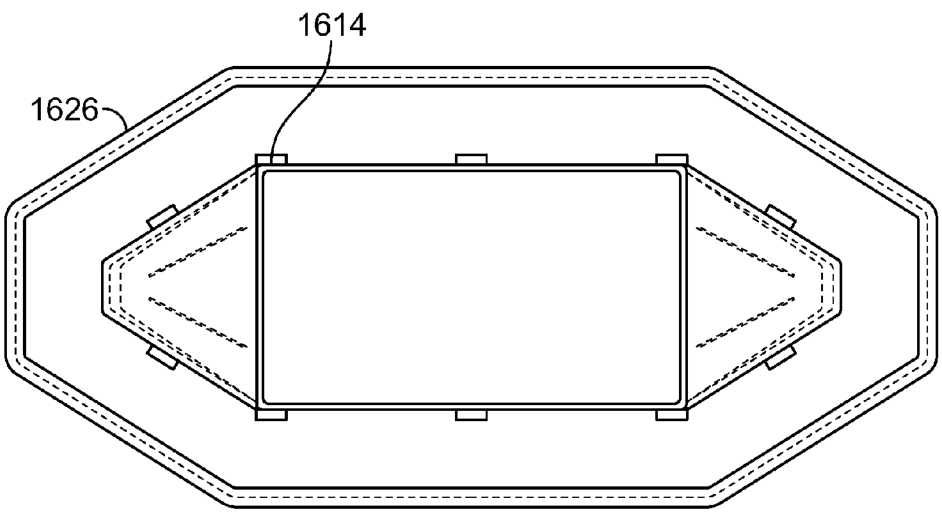

FIG. 20C

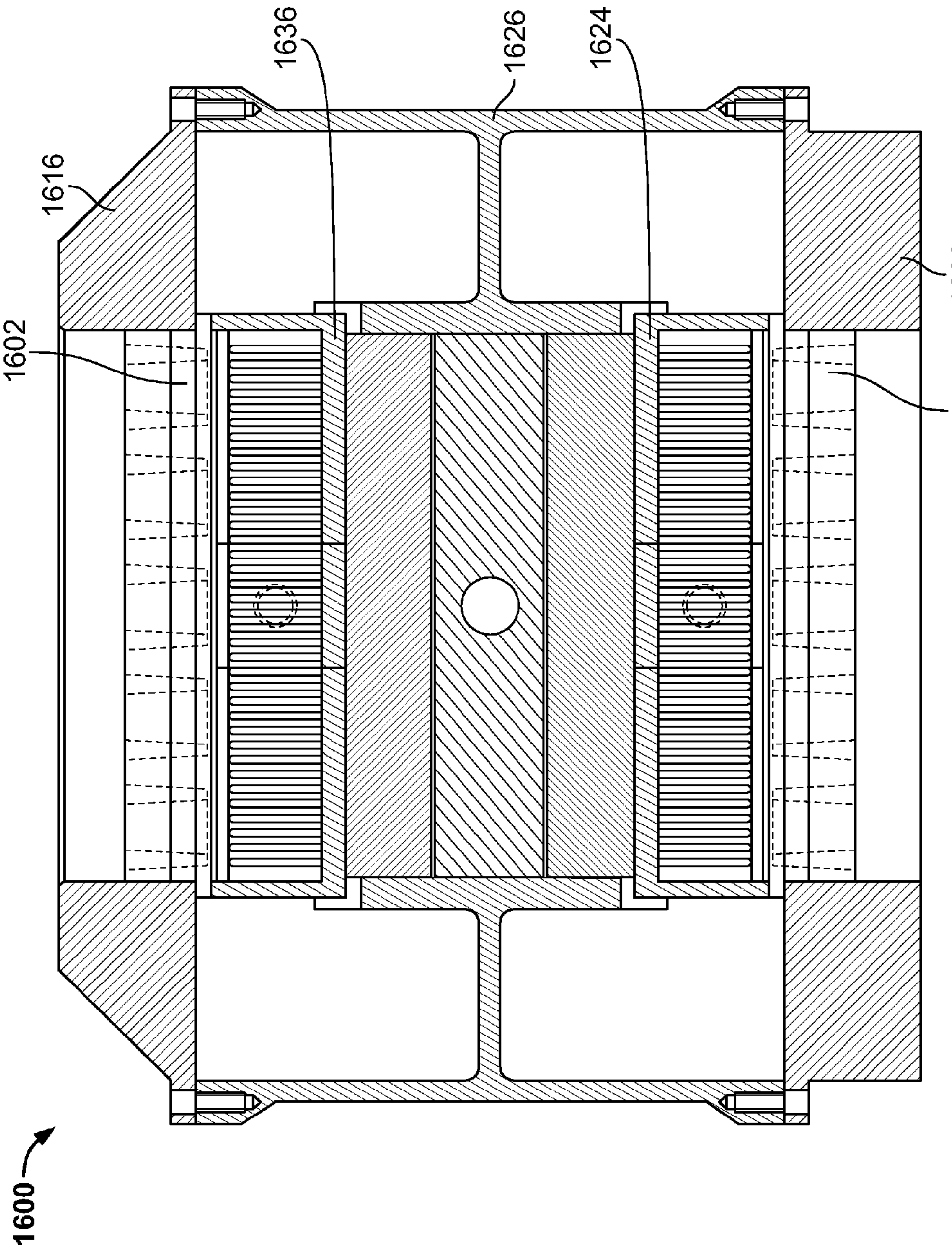

FIG. 21

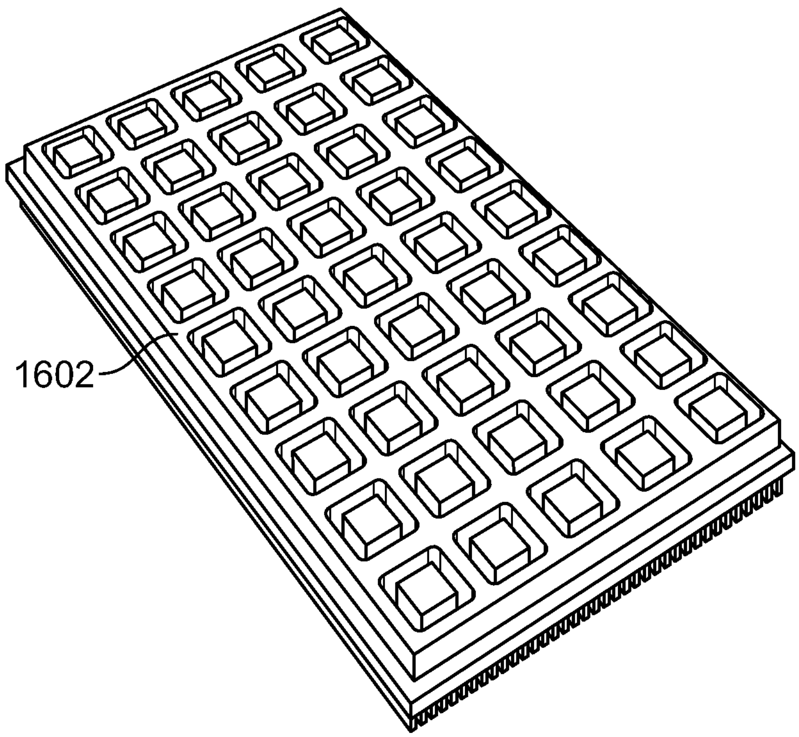

FIG. 22A

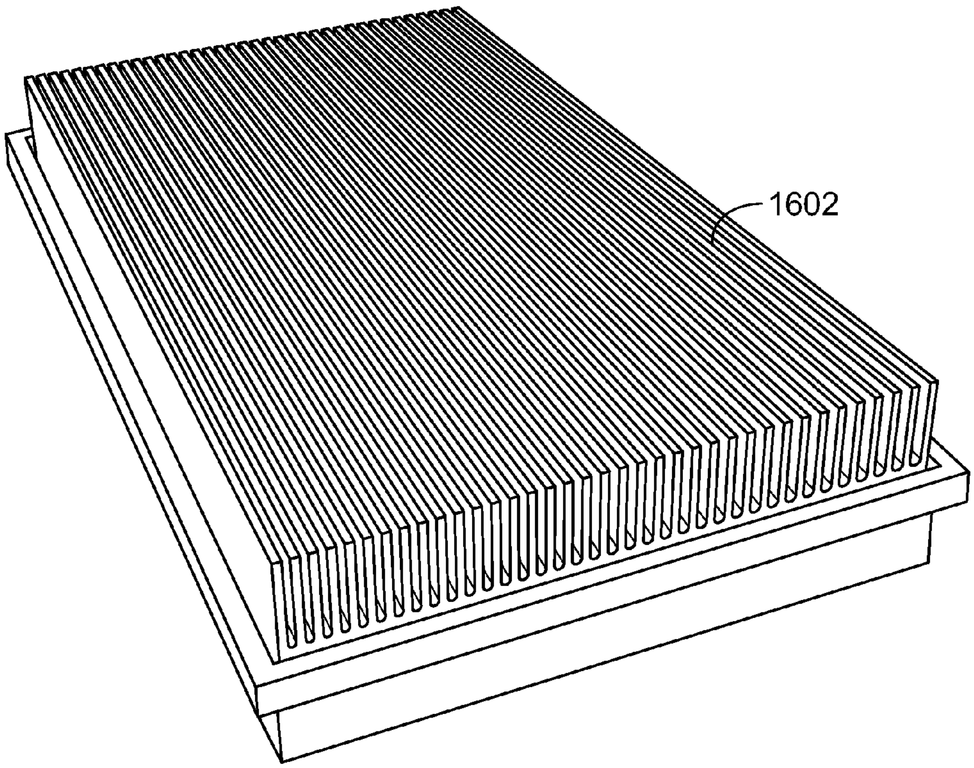

FIG. 22B

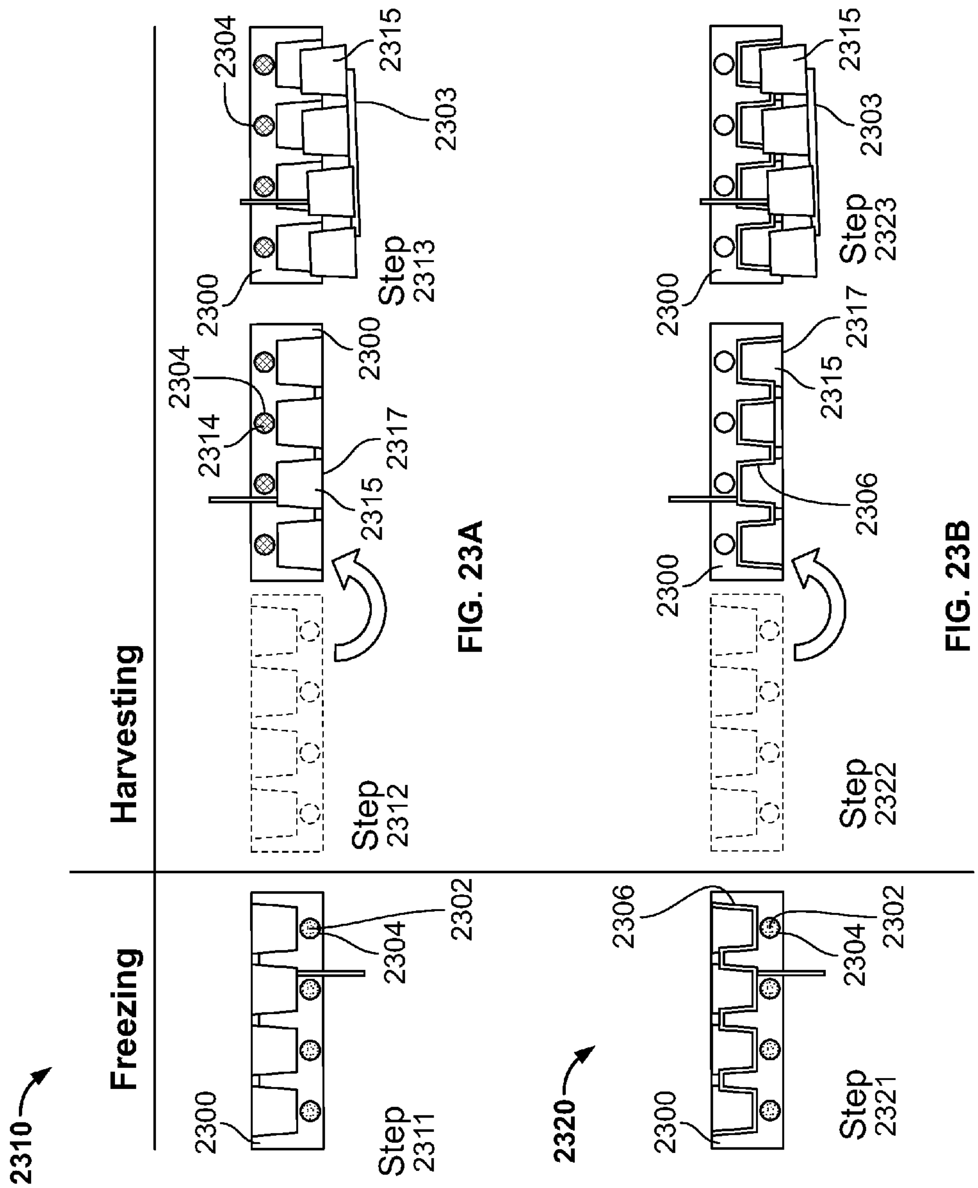

FIG. 23A

FIG. 23B

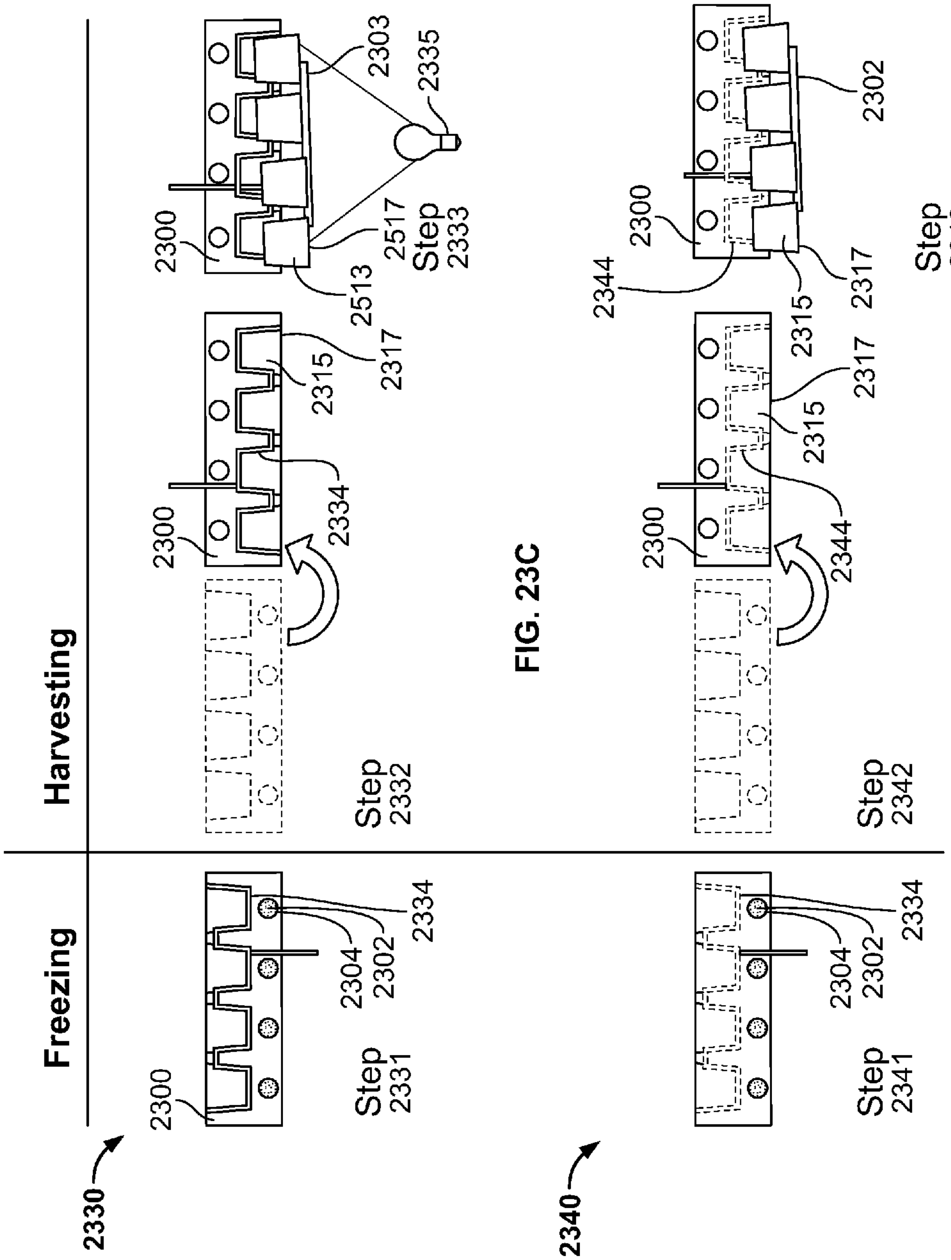

FIG. 23C

FIG. 23D

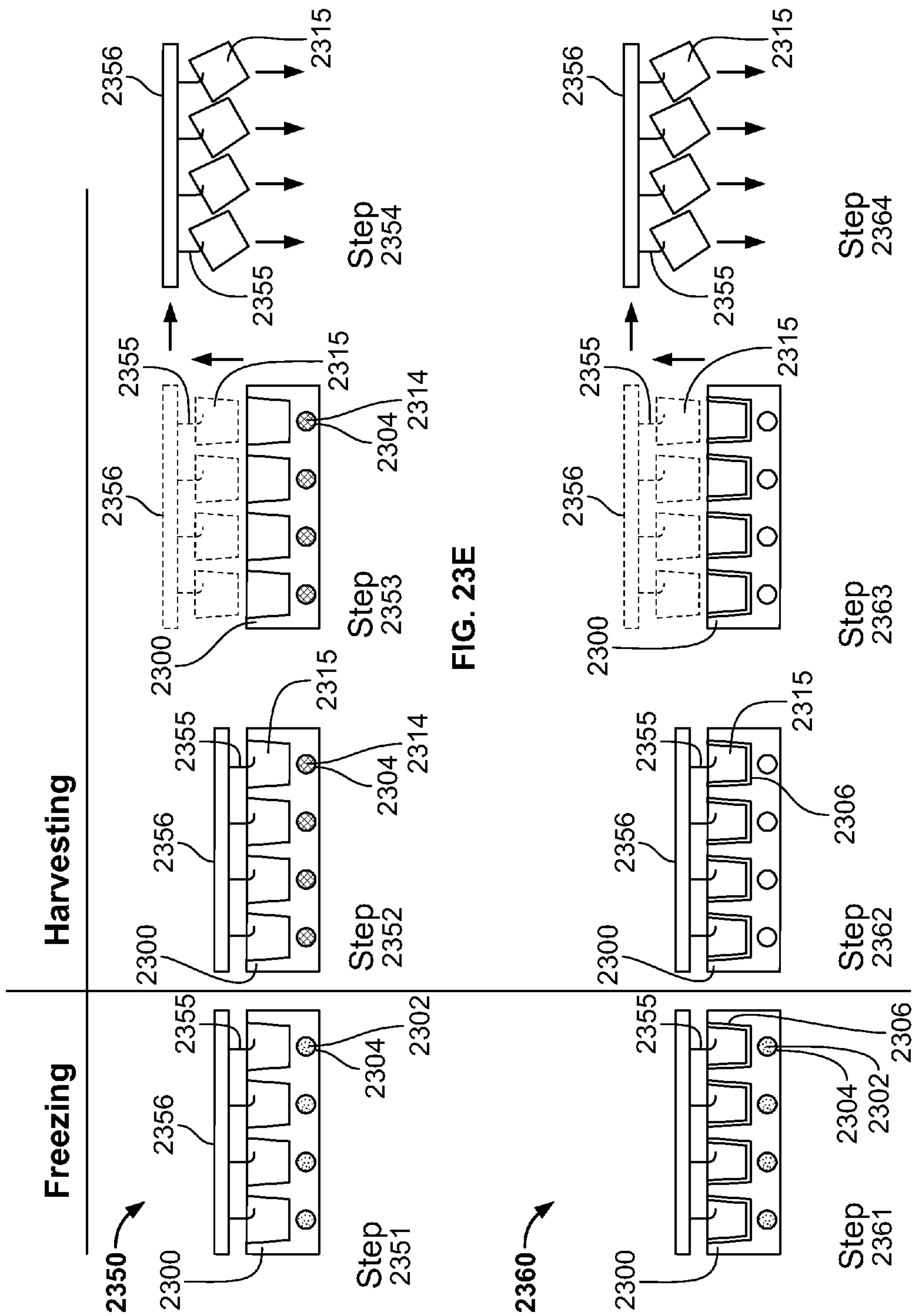

FIG. 23E

FIG. 23F

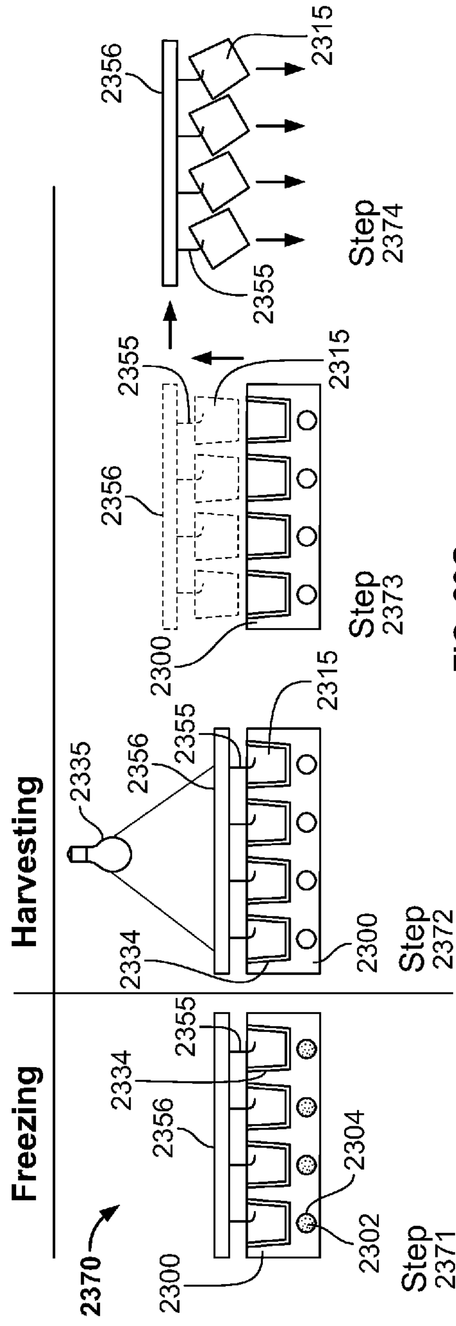

FIG. 23G

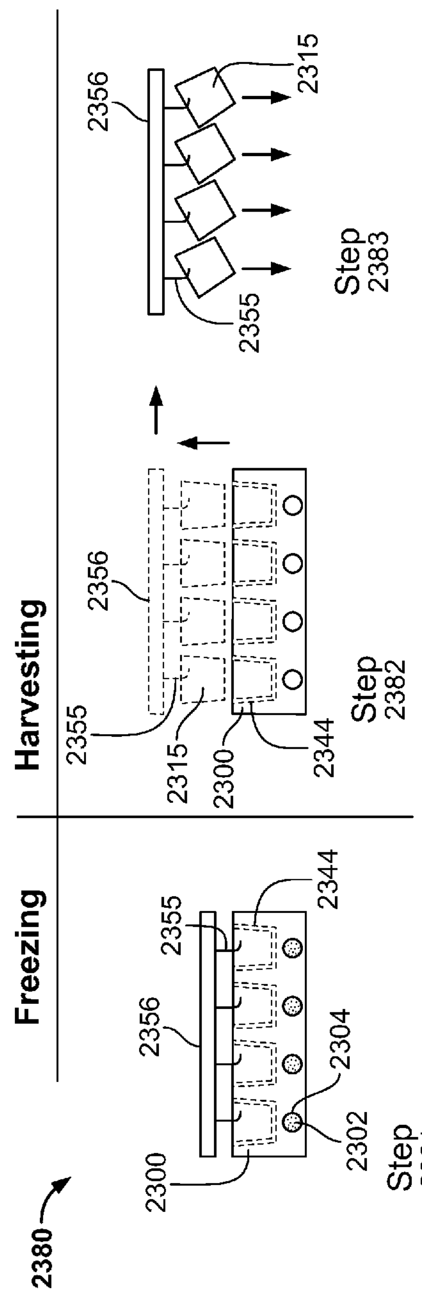

FIG. 23H

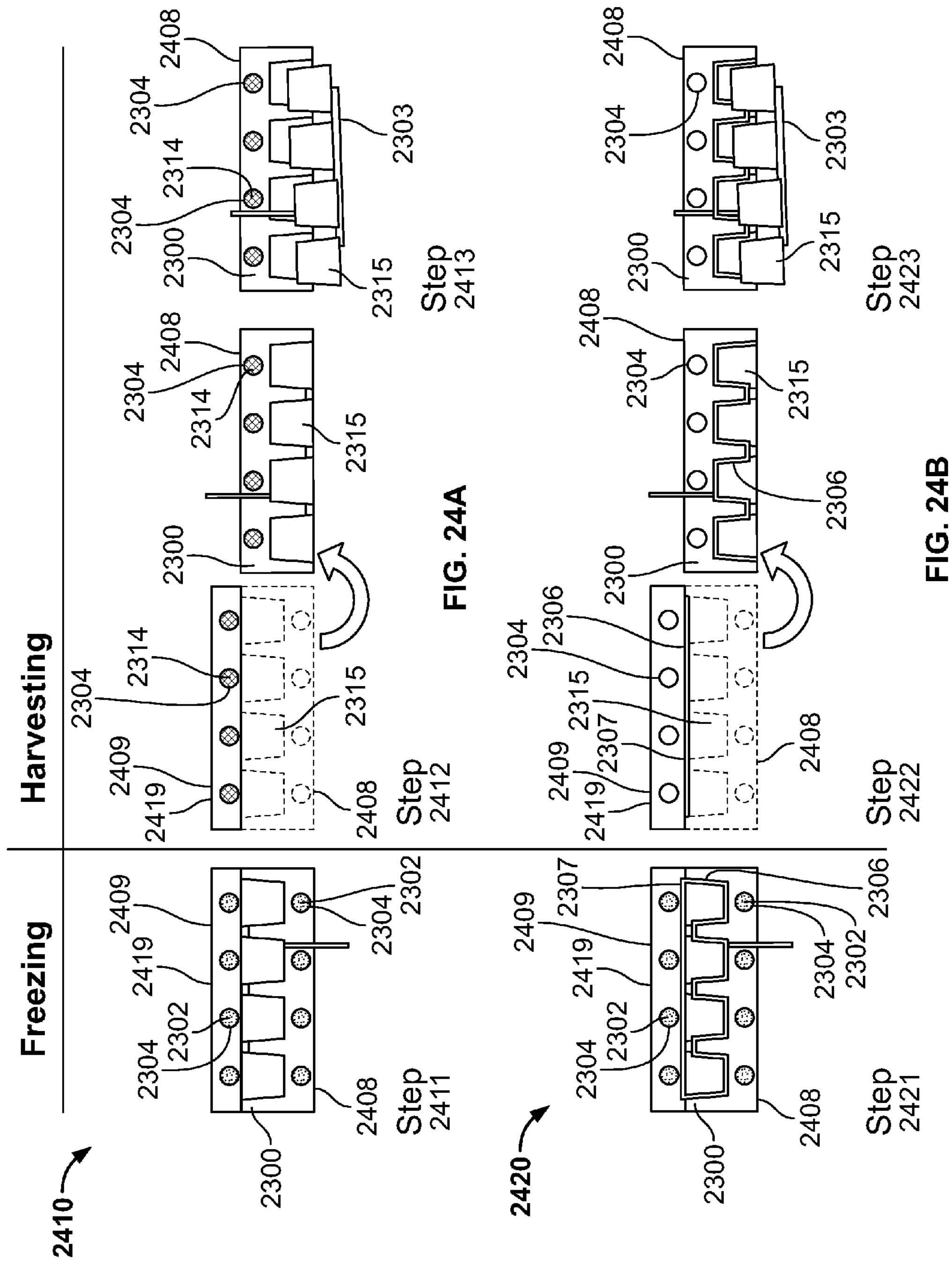

FIG. 24A

FIG. 24B

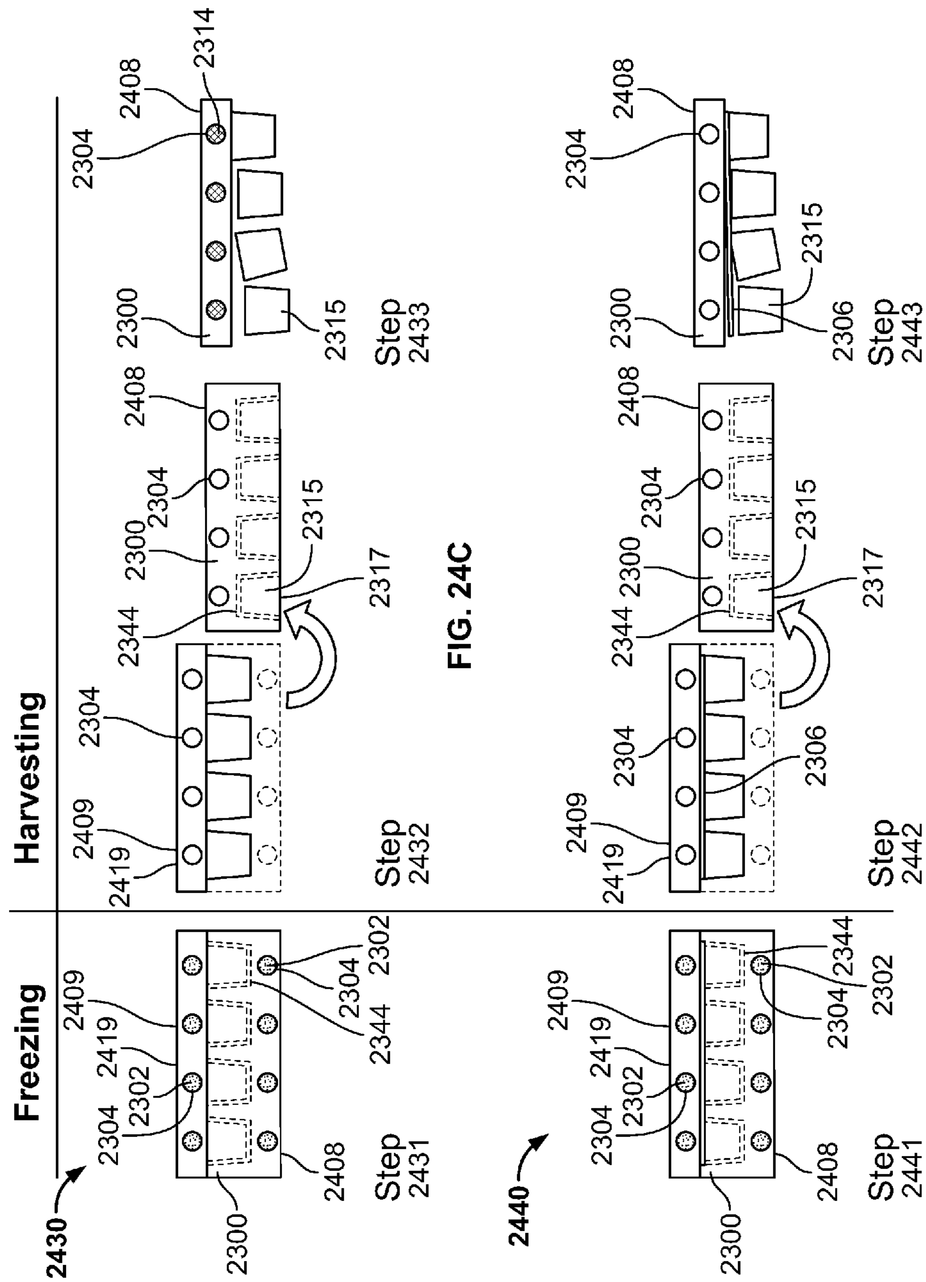

FIG. 24C

FIG. 24D

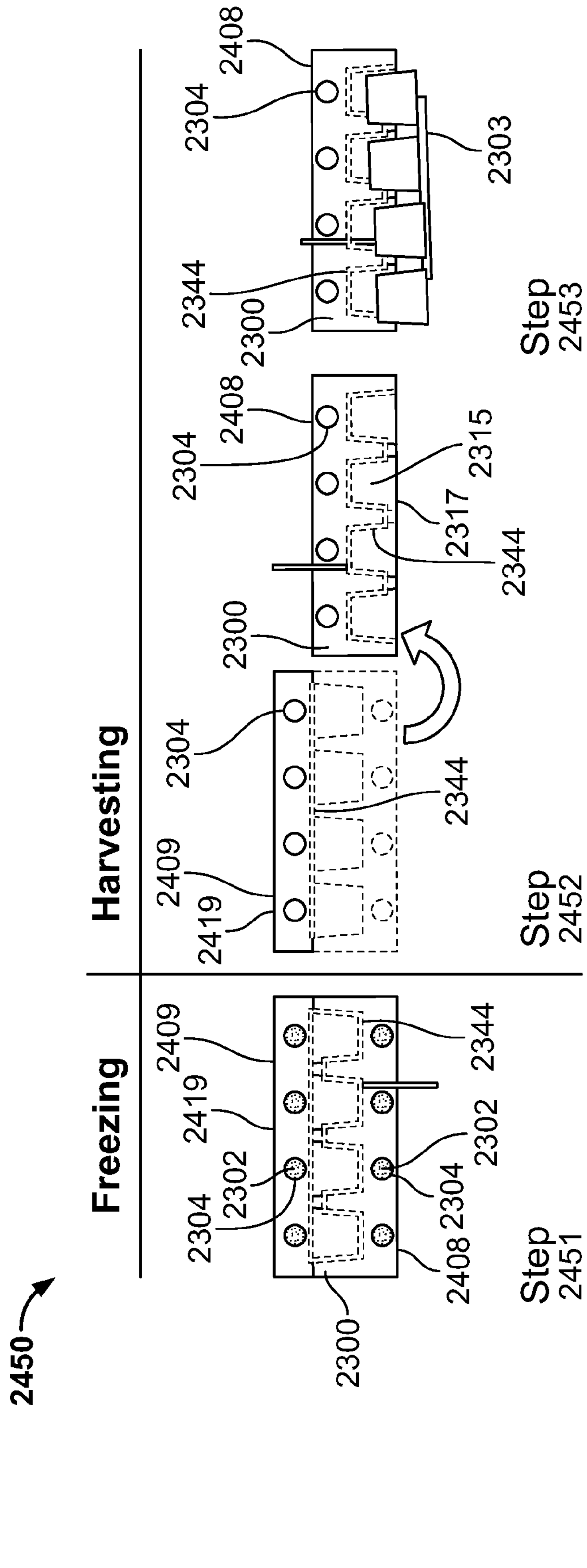
2450
Freezing
Harvesting
2304
2302
2419
2409
2344
2408
2300
Step 2451
Step 2452
Step 2453
2315
2317
2303

FIG. 24E

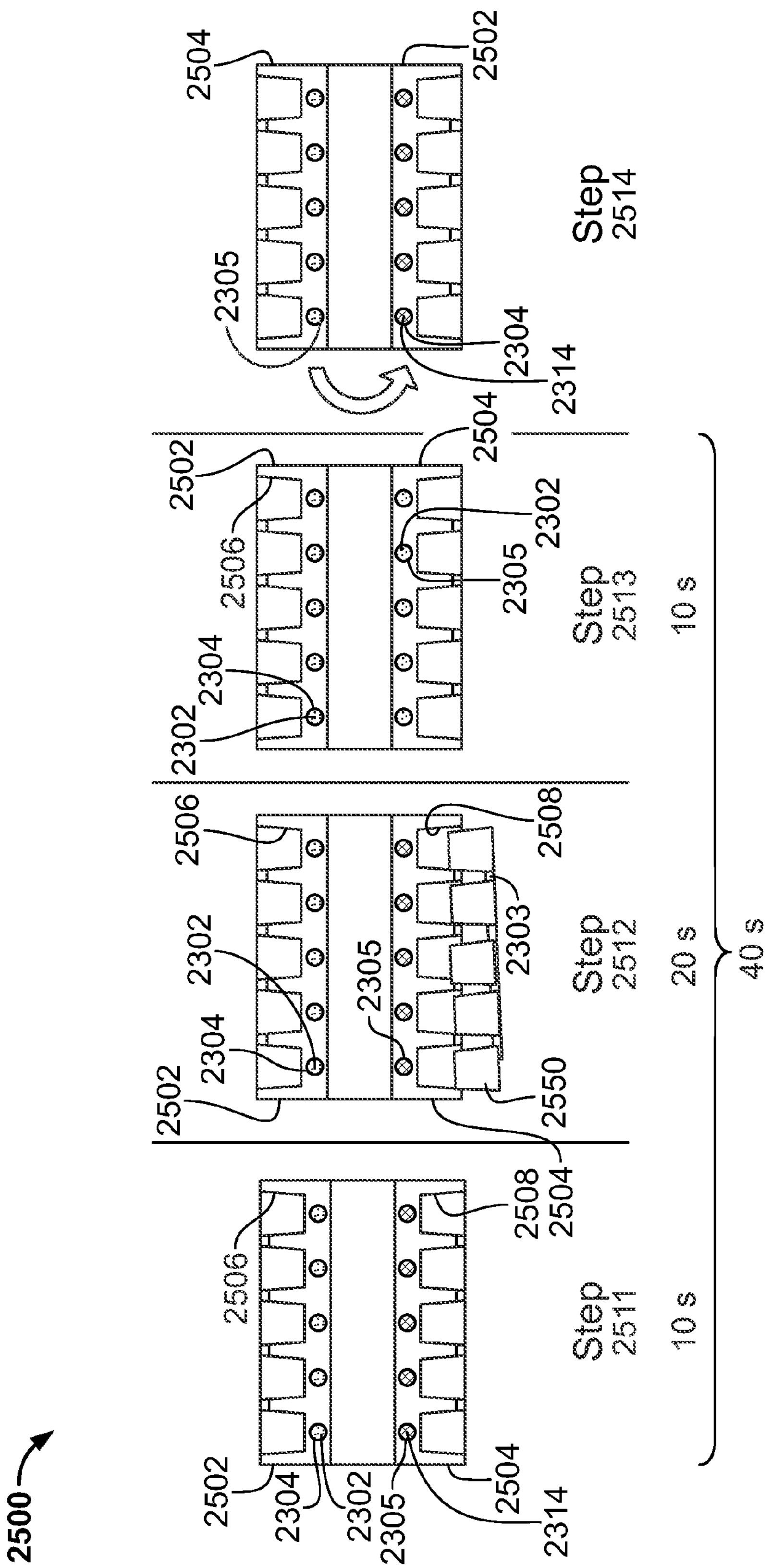
2500
2502
2304
2302
2305
2314
2504
2506
2508
Step 2511
10 s
2550
2303
Step 2512
20 s
40 s
Step 2513
Step 2514

FIG. 25

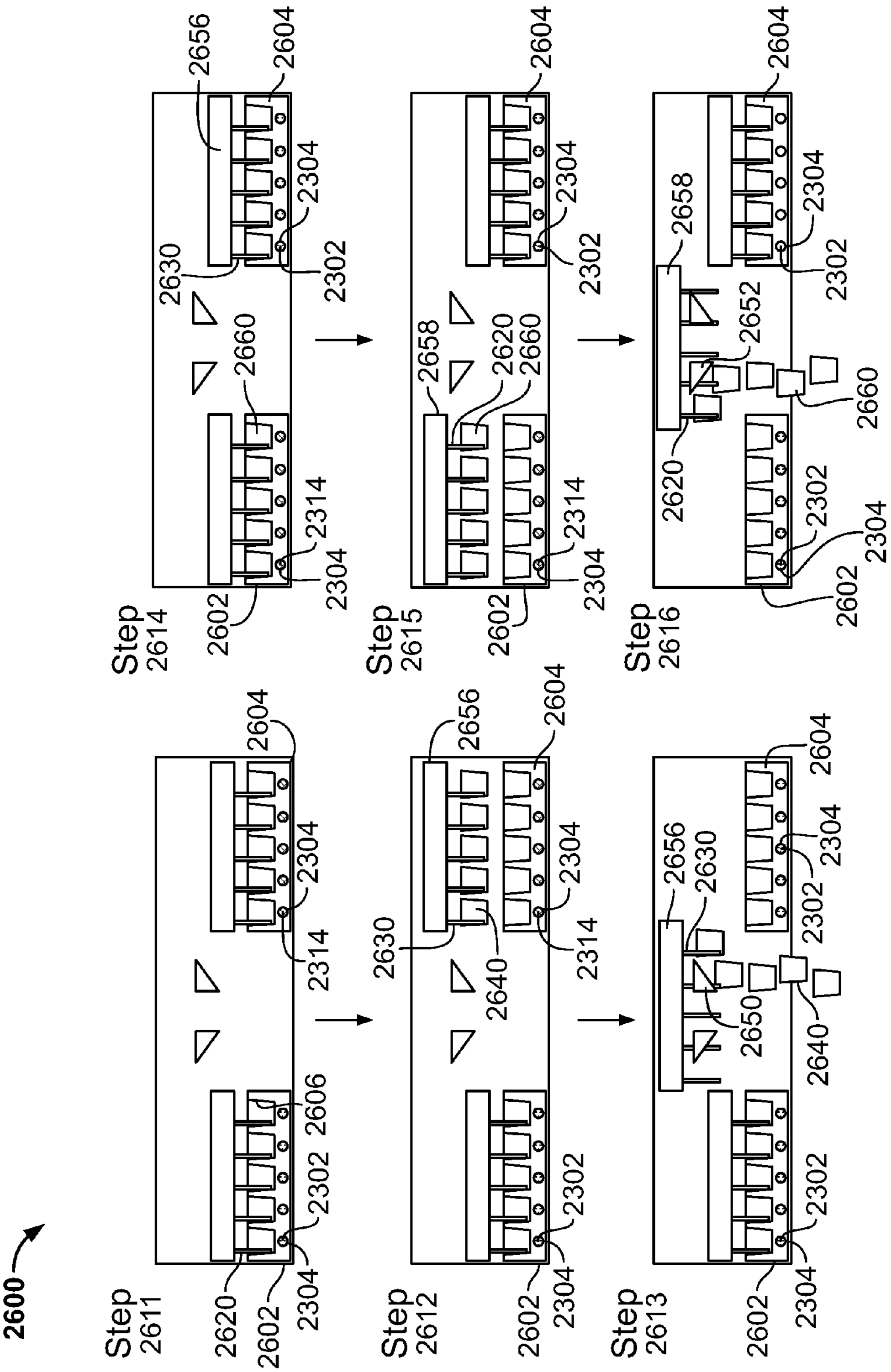
2600
Step 2611
Step 2612
Step 2613
Step 2614
Step 2615
Step 2616

FIG. 26

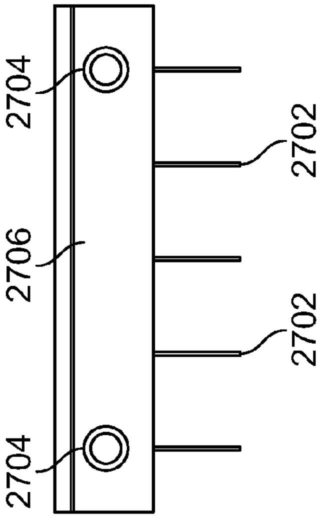

FIG. 27C

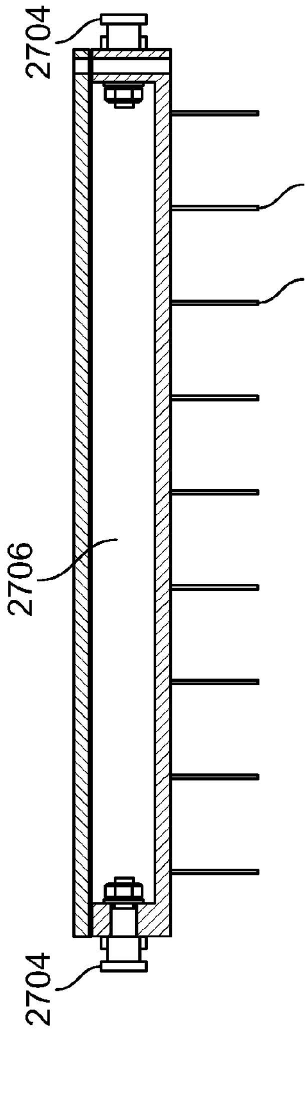

FIG. 27A

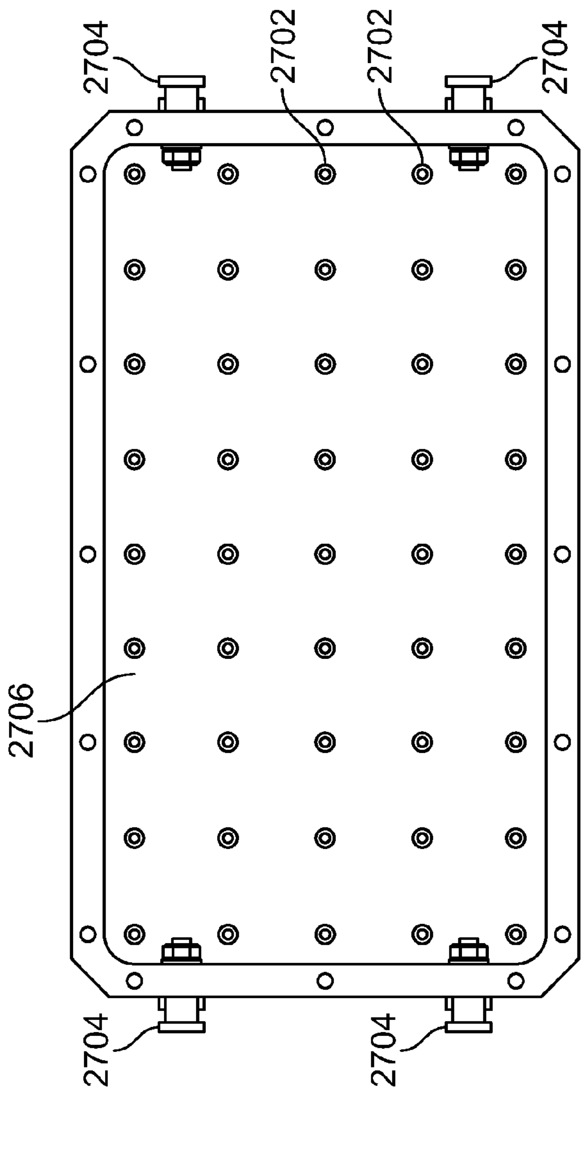

FIG. 27B

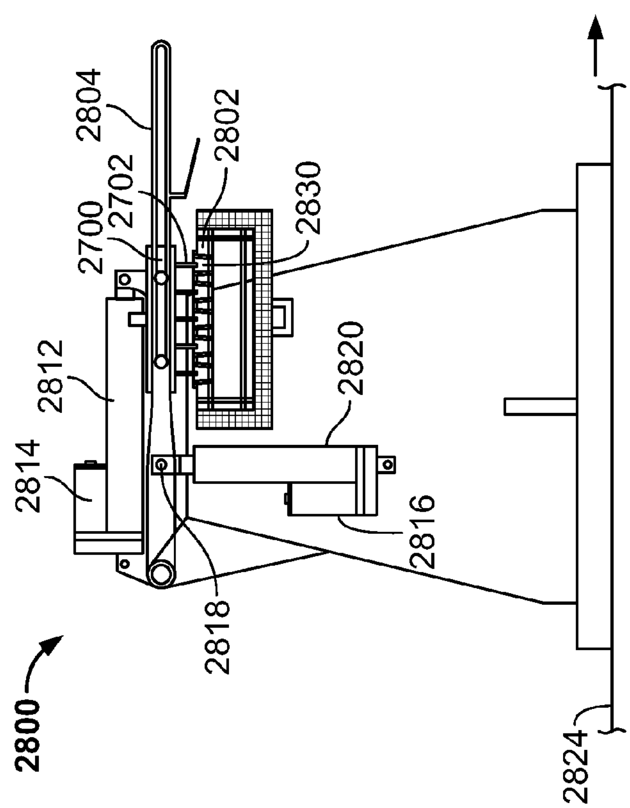

FIG. 28A

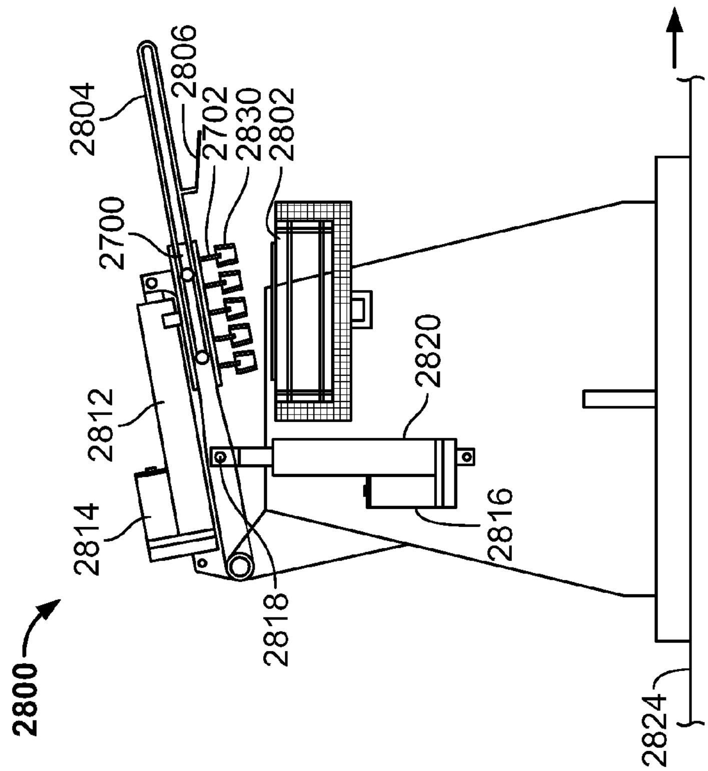

FIG. 28B

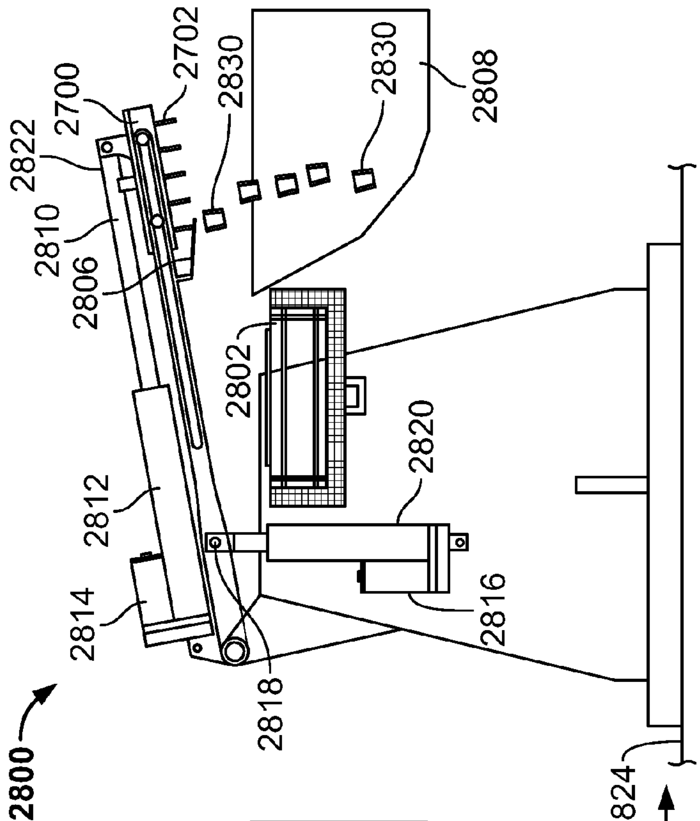

FIG. 28D

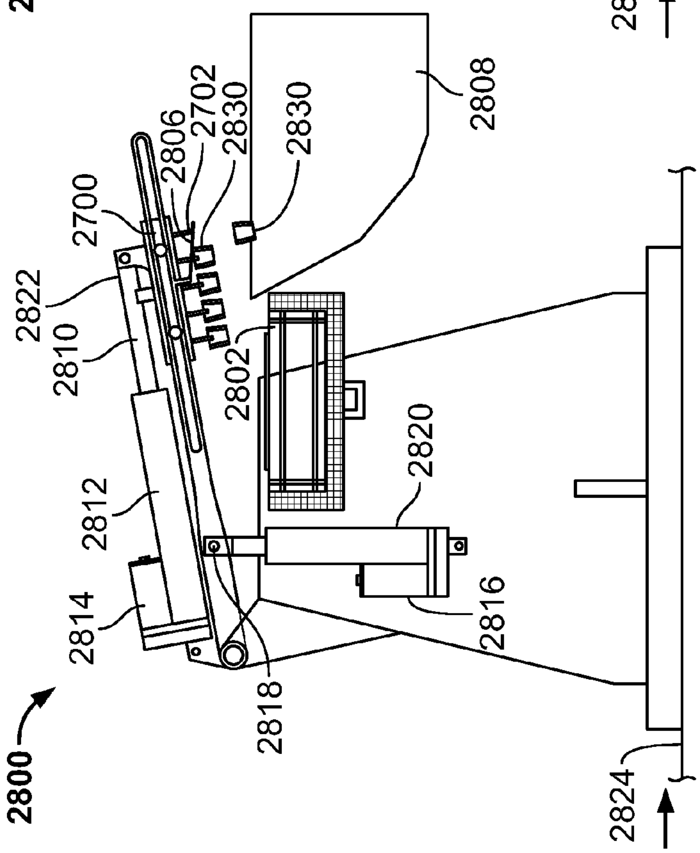

FIG. 28C

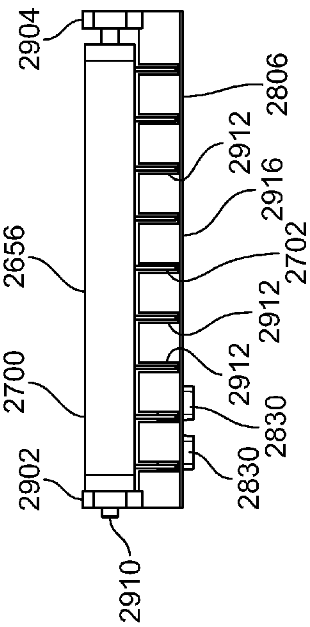

FIG. 29C

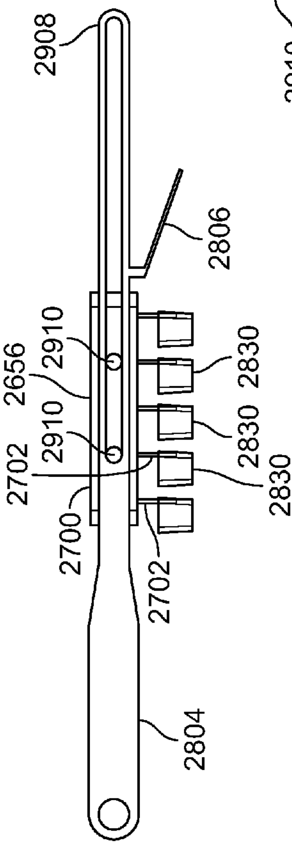

FIG. 29A

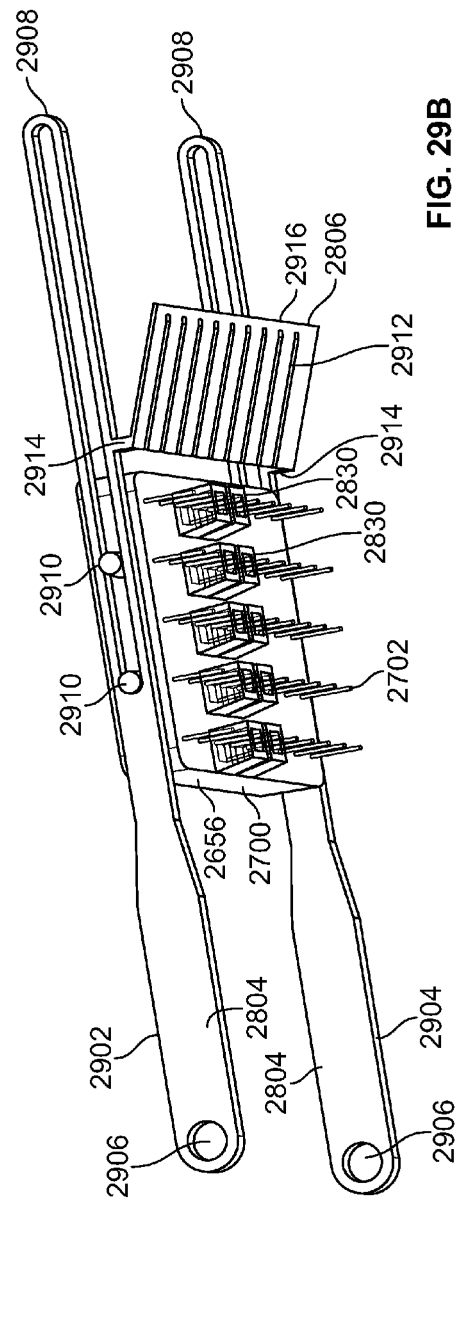

FIG. 29B

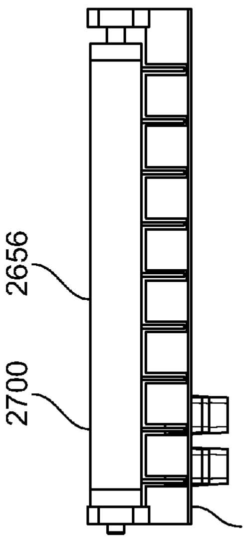

FIG. 29F

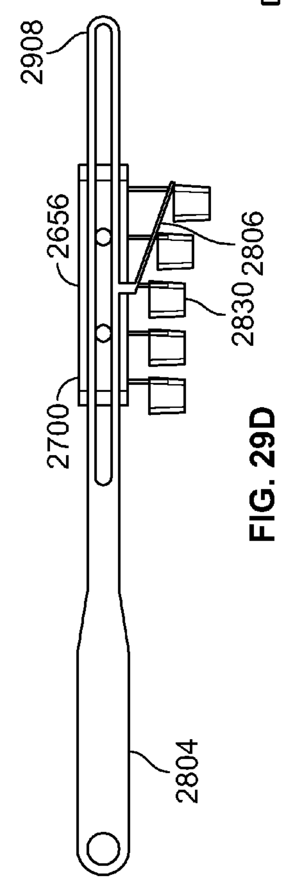

FIG. 29D

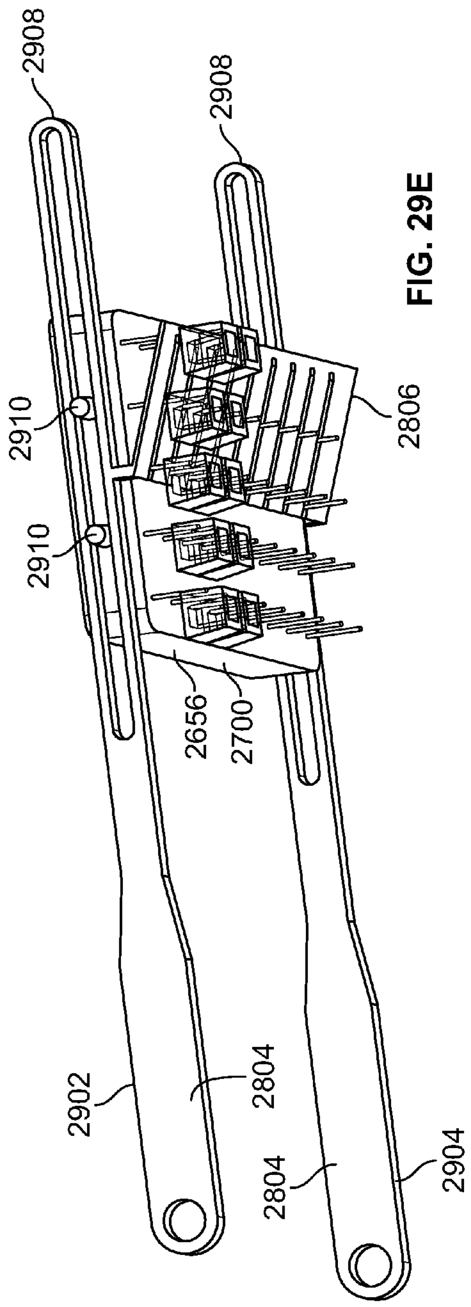

FIG. 29E

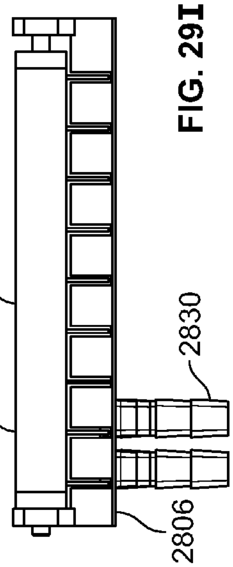

FIG. 29I

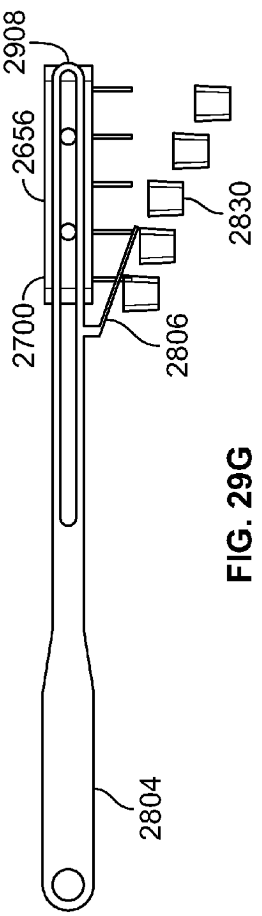

FIG. 29G

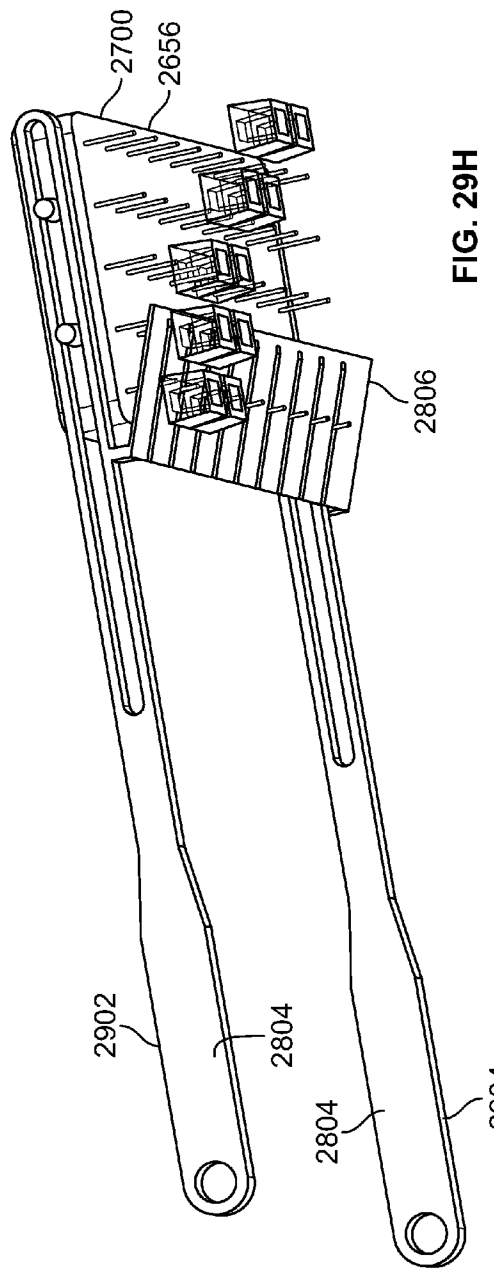

FIG. 29H

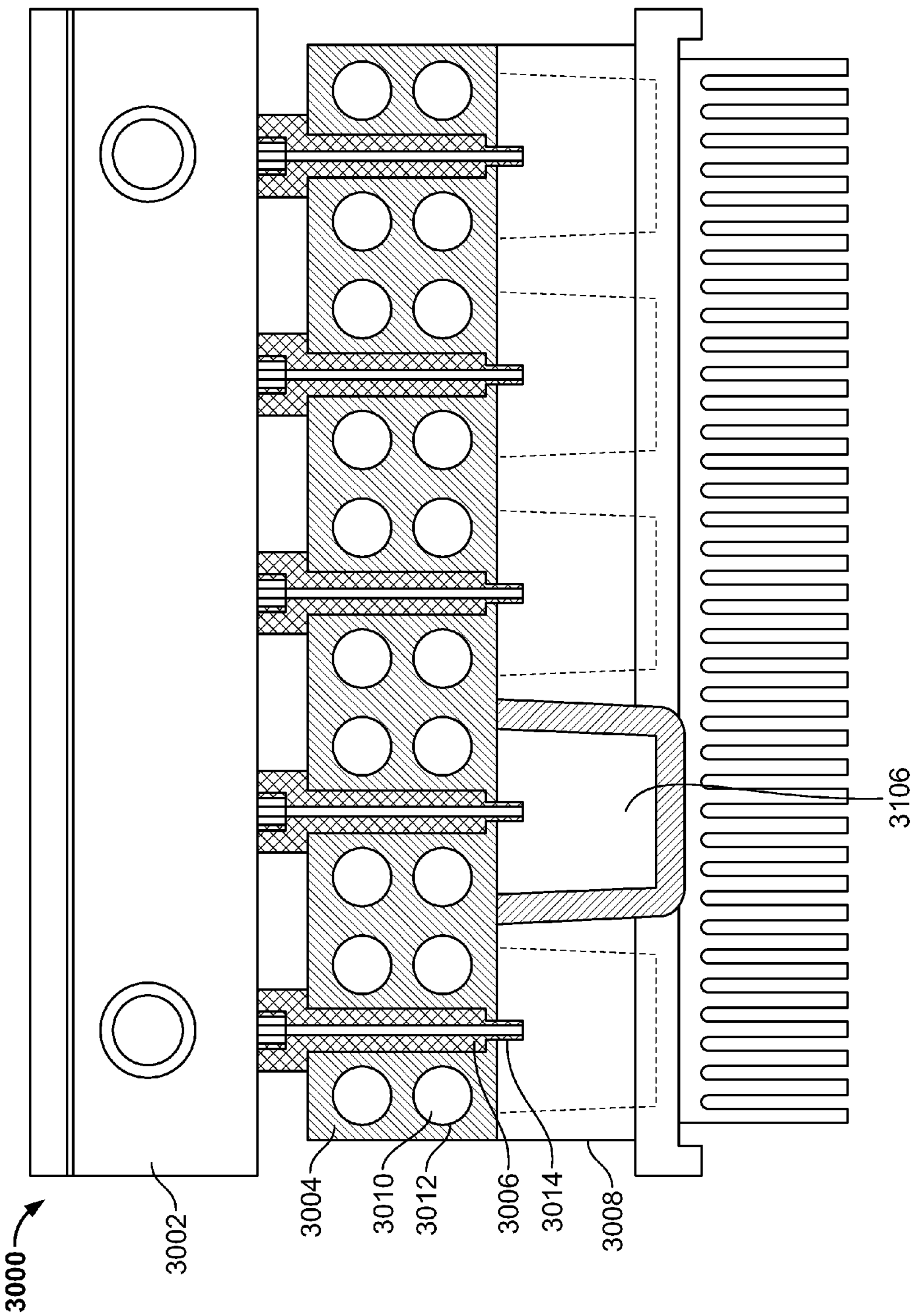

FIG. 30

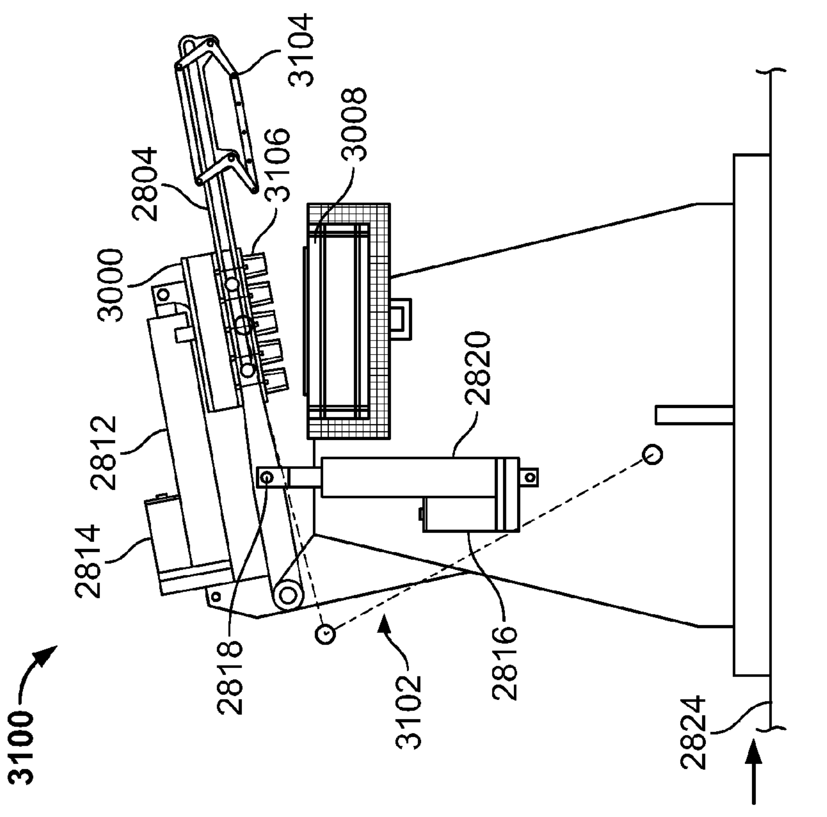

FIG. 31A

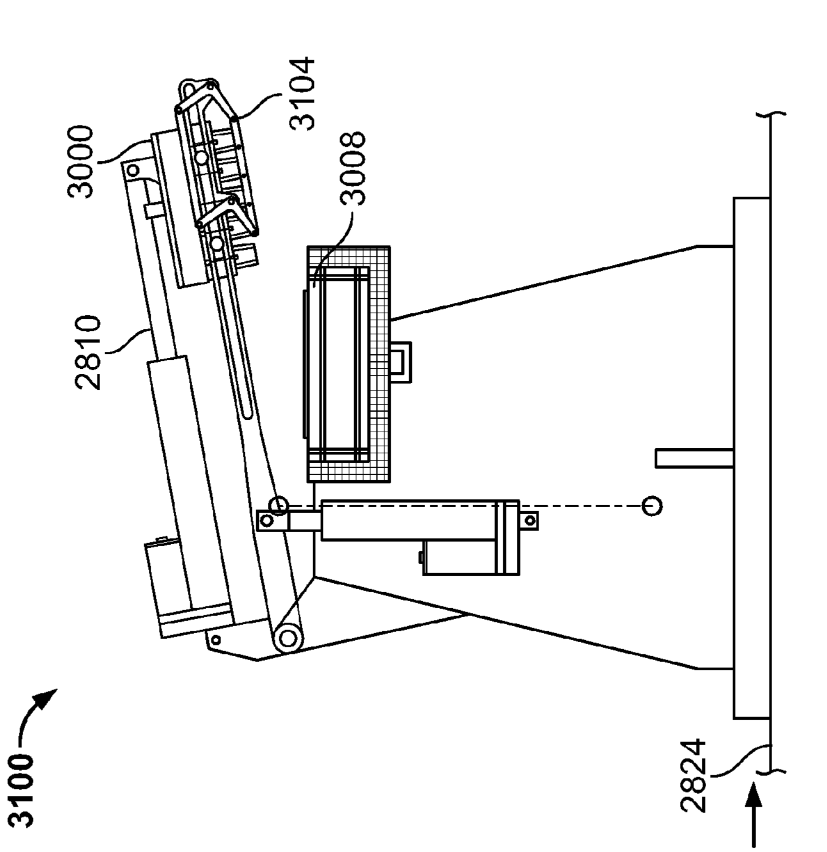

FIG. 31B

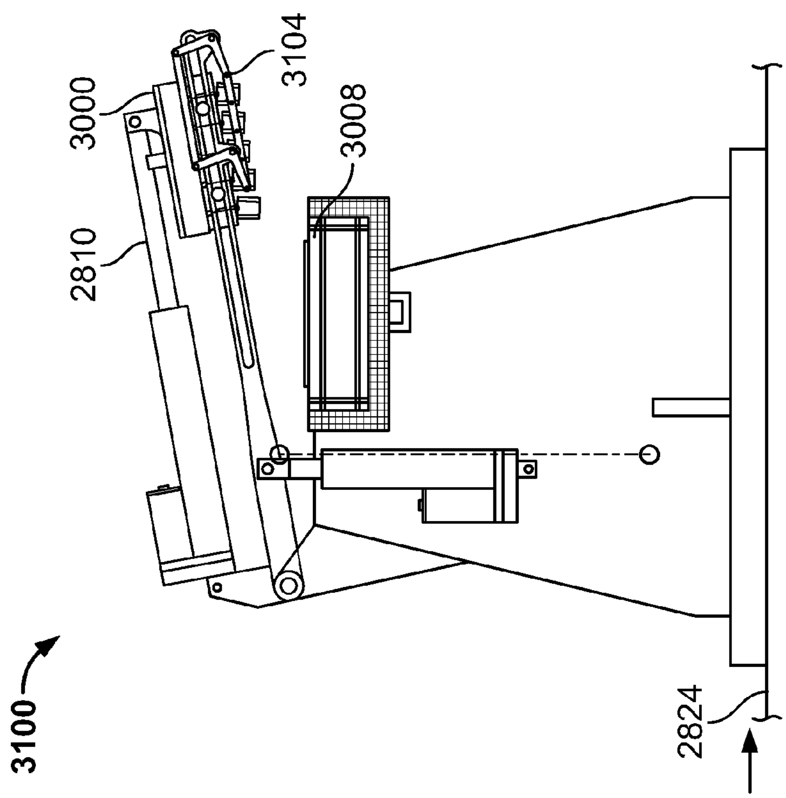

FIG. 31C

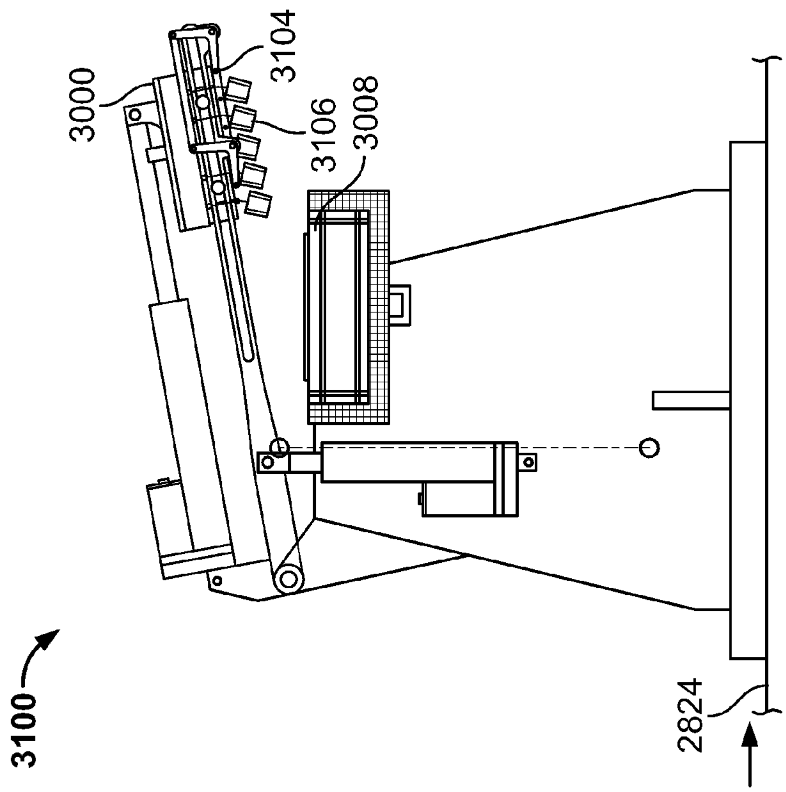

FIG. 31D

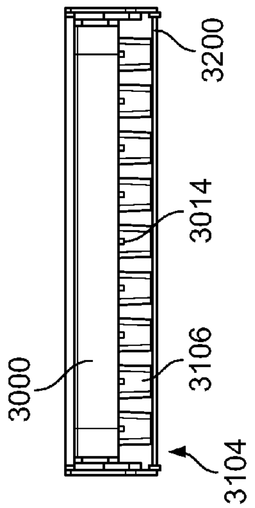

FIG. 32C

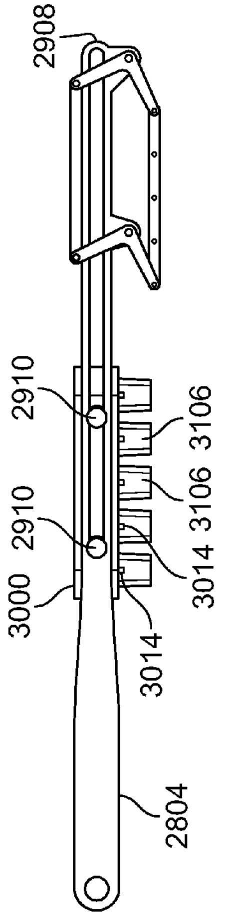

FIG. 32A

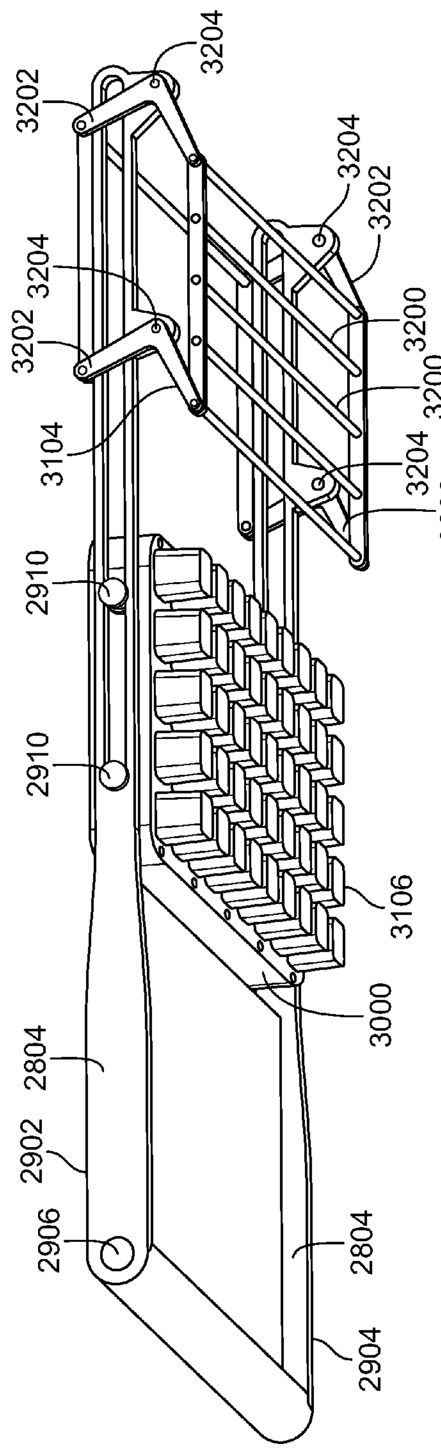

FIG. 32B

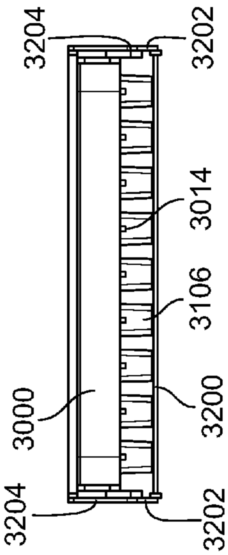

FIG. 32F

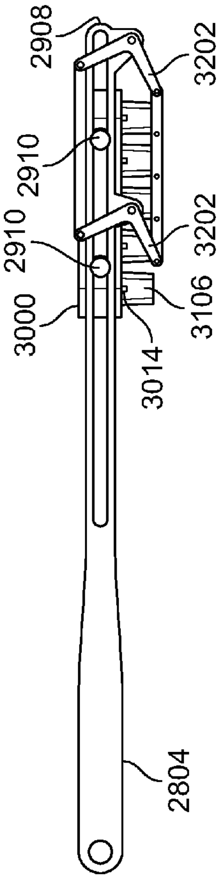

FIG. 32D

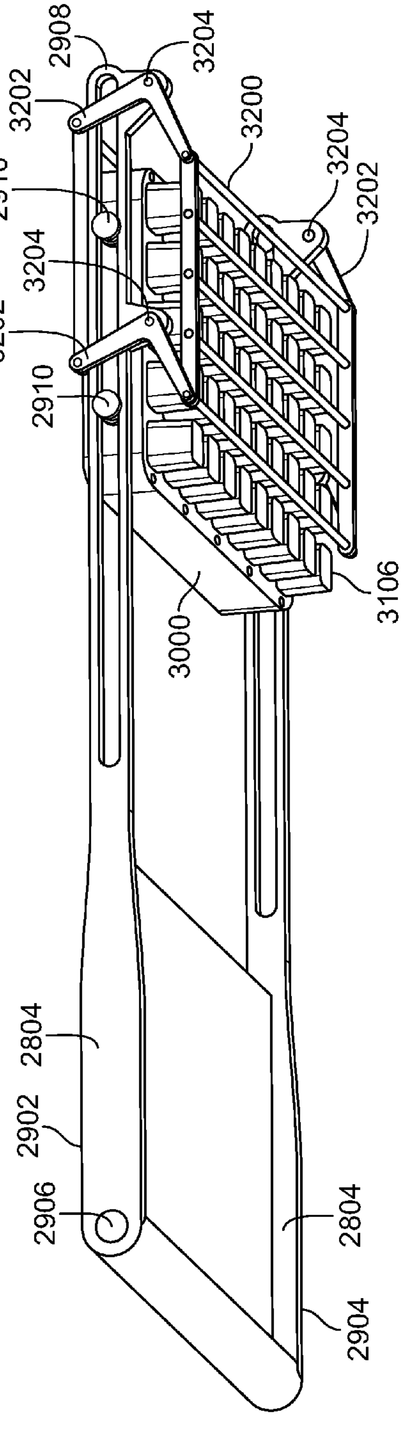

FIG. 32E

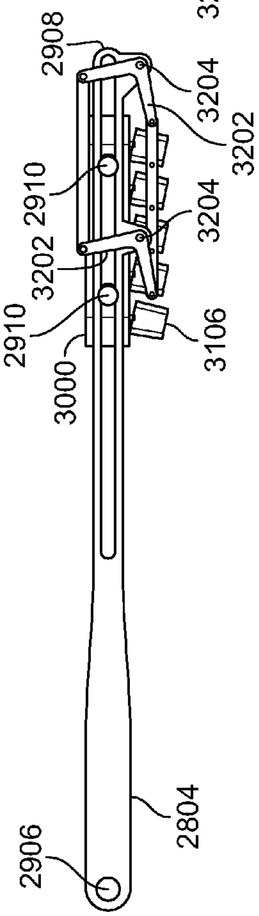

FIG. 32G

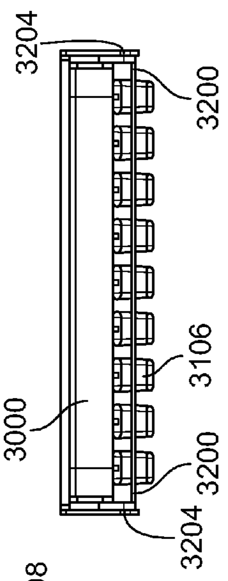

FIG. 32I

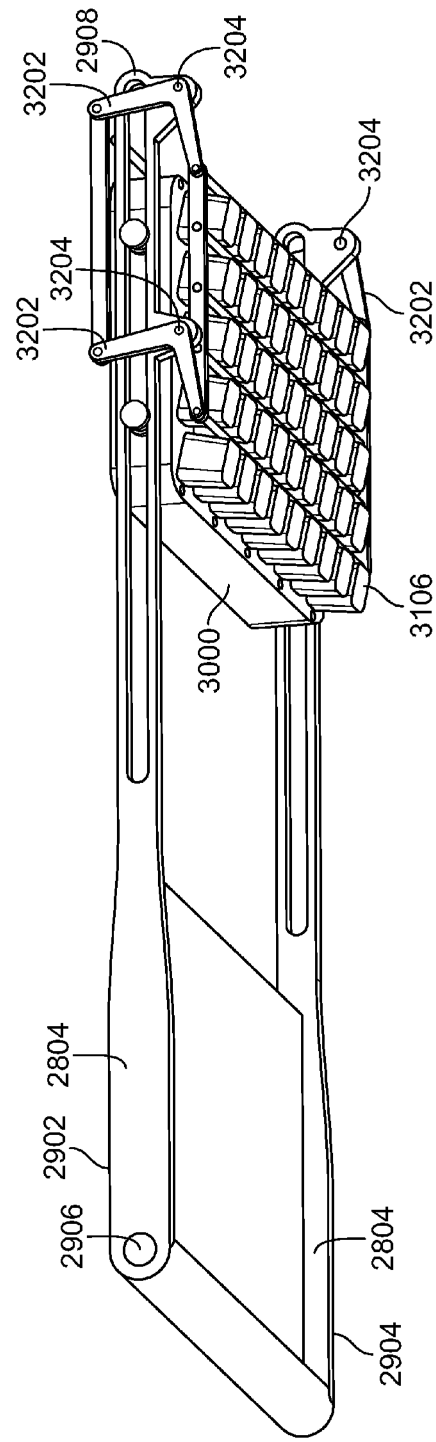

FIG. 32H

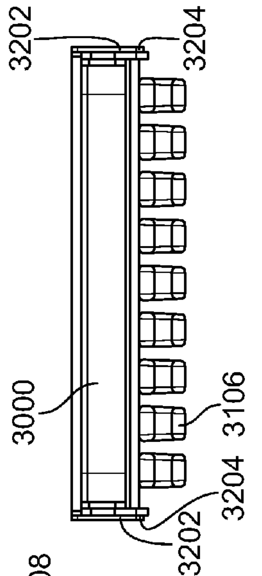

FIG. 32L

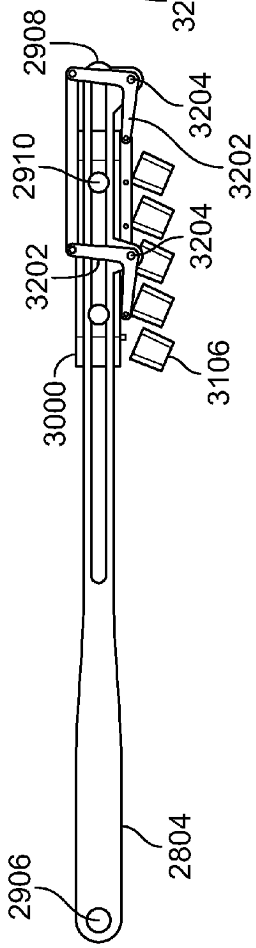

FIG. 32J

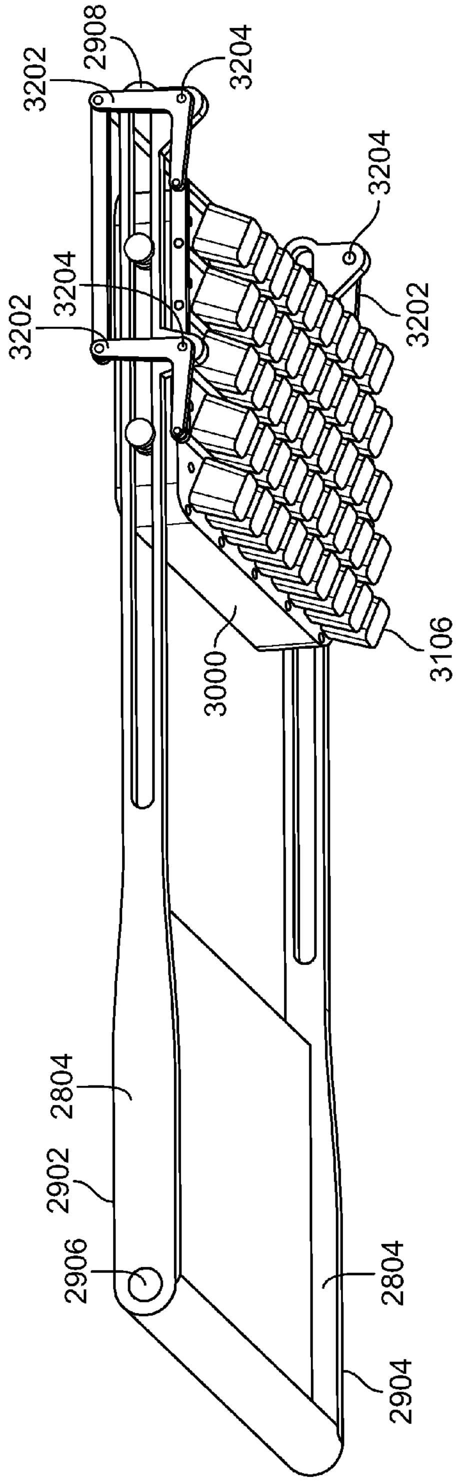

FIG. 32K

METHOD AND APPARATUS FOR ICE HARVESTING

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a non-provisional of and claims priority to pending provisional U.S. Application No. 61/588,954, filed Jan. 20, 2012, and entitled "Method and Apparatus for Ice Making," the entire disclosure of which is hereby incorporated by reference in its entirety and for all purposes.

FIELD OF THE INVENTION

[0002] This disclosure relates generally to a method and ice making apparatus for ice harvesting, wherein the ice may be used in a variety of settings, including beverage dispensers, e.g., for cafeterias, restaurants (including fast food restaurants), theatres, convenience stores, gas stations, and other entertainment and/or food service venues, with reduced overall dimensions of apparatus and decreased freezing time for ice.

BACKGROUND

[0003] Ice making machines described in the art typically form clear crystalline ice by freezing water that flows over a cooled surface.

[0004] Existing ice making machines have several shortcomings. For example, they form ice cubes relatively slowly, which leads to a low ice production rates at a given number of ice forming cells. For example, conventional ice making machines typically have ice production cycles of about 10-15 minutes. In order to provide required ice consumption during peak hours, conventional machines are typically equipped with a large size hopper. During storage, ice in the hopper requires mechanical agitation to avoid freezing of ice cubes together. This noticeably increases complexity and overall dimension of the ice making machine. Very often, a large hopper for ice storage is required, which in turn may require the hopper to be located remotely from the point of dispense. Transportation of ice from a remote location to the point of dispensing may add to complexity and operation of ice making. In addition, ice stored for a significant period of time may become contaminated. Conventional machines are not equipped to provide for harvesting of ice that is commensurate with ice production cycles of less than about 10-15 minutes.

[0005] Therefore there is a need for a new ice making machine, which would provide faster ice cube freezing, and enable close to "ice-on-demand" production and harvesting rates, which in turn translates to a smaller overall machine footprint.

SUMMARY

[0006] In an aspect of the disclosure an ice cube mold is provided. The mold defines a first volume for an ice cube, the mold comprising a bottom face having an inner perimeter and side faces. Each side face of the mold has a corresponding inner perimeter, a corresponding top edge, and a corresponding bottom edge. The corresponding top edge of each side face is longer than the corresponding bottom edge. Each side face extends inward from the corresponding top edge to the corresponding bottom edge. The mold comprises a three-dimensional shape, the three-dimensional shape located within the first volume, the three-dimensional shape comprising a second volume. The second volume is defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge of the three-dimensional shape. The bulge extends upwardly between the bottom outer perimeter and the top outer perimeter. The bulge tapers as it extends upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape. The mold further defines a third volume between the first volume and the second volume, with the mold configured to receive water within the third volume.

[0007] The above and other aspects, features and advantages of the present disclosure will be apparent from the following detailed description of the illustrated embodiments thereof which are to be read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIGS. **1**A through **1**L show ice cube geometries in accordance with at least one aspect of the disclosure.

[0009] FIG. **2** shows cross-sectional view of a mold fragment in accordance with at least one aspect of the disclosure.

[0010] FIGS. **3**A through **3**C show ice cubes of various geometries of bulges and fins which increase area mold-water interface in accordance with at least one aspect of the disclosure.

[0011] FIG. **4** shows cross-sectional view of the mold fragment in accordance with at least one aspect of the disclosure.

[0012] FIG. **5** shows ice cube configuration in accordance with at least one aspect of the disclosure.

[0013] FIG. **6** shows cross-sectional view of the mold fragment in accordance with at least one aspect of the disclosure.

[0014] FIG. **7** shows a cross-sectional view of the mold fragment in accordance with at least one aspect of the disclosure.

[0015] FIG. **8**A depicts percentage by volume of ice cube **150** versus time.

[0016] FIG. **8**B depicts ice cube wall thickness in mm versus time.

[0017] FIGS. **9**A through **9**F depict portions of ice cubes that comprise water and portions of ice cubes that comprise ice after 30 seconds of freezing in accordance with at least one aspect of the disclosure.

[0018] FIGS. **10**A through **10**D illustrate an ice cube in accordance with at least one aspect of the disclosure.

[0019] FIGS. **11**A through **11**D illustrate another ice cube in accordance with at least one aspect of the disclosure.

[0020] FIGS. **12**A through **12**D illustrate an additional ice cube in accordance with at least one aspect of the disclosure.

[0021] FIGS. **13**A through **13**D illustrate yet a further ice cube in accordance with at least one aspect of the disclosure.

[0022] FIG. **14** illustrates time to freeze 95% by volume and time to achieve complete freezing of ice cubes in accordance with at least one aspect of the disclosure.

[0023] FIGS. **15**A through **15**D illustrate a distribution apparatus in accordance with at least one aspect of the disclosure.

[0024] FIG. **16**A is a perspective view of an assembled embodiment of back-to-back ice cube molds in accordance with at least one aspect of the disclosure.

[0025] FIG. **16**B is an exploded view of the embodiment shown in FIG. **16**A.

[0026] FIG. **17**A and FIG. **17**B illustrate a mold shown in FIG. **16**A and FIG. **16**B in accordance with at least one aspect of the disclosure.

[0027] FIG. 18A is a side view of a mold in accordance with at least one aspect of the disclosure.
[0028] FIG. 18B is a bottom view of the mold shown in FIG. 18A.
[0029] FIG. 19 is a bottom view a cover in accordance with at least one aspect of the disclosure.
[0030] FIGS. 20A through 20C illustrate an embodiment in accordance with at least one aspect of the disclosure.
[0031] FIG. 21 illustrates a full assembly cross section view and an exploded perspective view of an embodiment in accordance with at least one aspect of the disclosure.
[0032] FIG. 22A and FIG. 22B are top and bottom perspective views of an embodiment in accordance with at least one aspect of the disclosure.
[0033] FIGS. 23A through 23H illustrate various ice harvesting procedures, each of which includes at least one aspect of the disclosure.
[0034] FIGS. 24A through 24E illustrate additional various ice harvesting procedures, each of which includes at least one aspect of the disclosure.
[0035] FIG. 25 illustrates another ice harvesting procedure that includes at least one aspect of the disclosure.
[0036] FIG. 26 illustrates yet another ice harvesting procedure that includes at least one aspect of the disclosure.
[0037] FIGS. 27A through 27C illustrate an embodiment in accordance with at least one aspect of the disclosure.
[0038] FIGS. 28A through 28D illustrate an ice harvesting and apparatus in accordance with at least one aspect of the disclosure.
[0039] FIGS. 29A through 29I illustrate ice harvesting and apparatus in accordance with at least one aspect of the disclosure.
[0040] FIG. 30 illustrates a side view of a water filling system in accordance with at least one aspect of the disclosure.
[0041] FIGS. 31A through 31D illustrate ice harvesting and apparatus in accordance with at least one aspect of the disclosure.
[0042] FIGS. 32A through 32L illustrate ice harvesting and apparatus in accordance with at least one aspect of the disclosure.

DETAILED DESCRIPTION

[0043] In an aspect of the disclosure, an ice making machine may be provided with reduced overall dimensions and decreased freezing time of an ice cube to provide "ice-on-demand" production.
[0044] In an aspect, heat flow from water in a mold may be increased toward the mold. The heat flow may be enhanced by increasing area of a mold-water interface.
[0045] In an aspect, a predetermined ice cube shape may be used to reduce freezing time. The predetermined ice cube shape may have a shape of a truncated pyramid similar to a regular dice ice cube.
[0046] In an aspect, a mold with a plurality of cells and plurality of channels for cooling agent may be used. In order to provide freezing of water surface at the open side of a cell, an evaporator may be utilized. The ice making machine may comprise a cooling agent distribution system configured to deliver a pathway for a cooling agent that provides substantially equal heat removal from a plurality of ice cube molds.
[0047] In an aspect of the disclosure an ice making apparatus may be provided. The ice making apparatus may comprise a mold, the mold defining a first volume for an ice cube, the mold comprising a bottom face having an inner perimeter and side faces. Each side face of the mold may have a corresponding inner perimeter, a corresponding top edge, and a corresponding bottom edge. The corresponding top edge of each side face may be longer than the corresponding bottom edge. Each side face may extend inward from the corresponding top edge to the corresponding bottom edge. The mold may comprise a three-dimensional shape, the three-dimensional shape located within the first volume, the three-dimensional shape comprising a second volume. The second volume may be defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge of the three-dimensional shape. The bulge may extend upwardly between the bottom outer perimeter and the top outer perimeter. The bulge may taper as it extends upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape. The mold may further define a third volume between the first volume and the second volume, with the mold configured to receive water within the third volume. The apparatus may comprise a cooling device configured to cool water within the third volume sufficiently to freeze the water.

[0048] In one aspect of the disclosure an ice making apparatus may be provided comprising a mold. The mold may comprise an upper part and a lower part. Each of the parts may comprise a plurality of ice cube mold cells corresponding to a plurality of ice cube mold cells of the other mold part. The mold may be configured so that a first mold cell of the lower part of the mold and a corresponding second cell of the upper part of mold comprises a single enclosure. The single enclosure may define a volume for a single ice cube. A first channel may be configured to fill the first mold cell and the corresponding second mold cell with water. A second channel may be configured to allow air to escape from the single enclosure when the first mold cell and the second mold cell are filled with water. A plurality of passageways may be configured to receive a cooling agent and provide sufficient heat transfer from water within the mold cells to the mold cells, and freezing the water within the mold cells.

[0049] In an aspect, an ice making apparatus may be provided that comprises an evaporator. The evaporator may be separate from the mold. The evaporator and the mold may be combined wherein evaporation occurs in the mold. A dual or two loop system may be employed. In a two loop system, evaporation occurs in an evaporator, e.g., a heat carrier is cooled in the evaporator. After being cooled in the evaporator, the heat carrier is placed in heat transfer contact with the mold, and the heat carrier cools the mold. In an aspect, the heat carrier flows through a portion of the mold to cool the mold.

[0050] In one aspect of the disclosure, an ice making apparatus may be provided comprising a mold and a plate. The mold may be positioned over the plate. The mold may comprise a plurality of ice cube mold cells, each ice cube mold cell may comprise an opening at the bottom of the cell, and an air escape channel at the top of the cell to allow air to escape from the ice cube mold cell when the plate is filled with water. The mold and the plate may each comprise a plurality of passageways, each passageway configured to receive a cooling agent and provide sufficient heat transfer from water within the ice cube mold cells to the ice cube mold cells, and freeze water within the ice cube mold cells. Each ice cube mold cell may comprise a corresponding channel to allow air to escape from the ice cube mold cell when the plate is filled with water.

[0051] In one aspect of the disclosure, a method of making a plurality of ice cubes may be provided. The method may comprise placing a mold over a plate. The mold may comprise a plurality of cells. Each cell may comprise an opening at the bottom of the cell, and an air escape channel at the top of the cell. The method may comprise filling each of the plurality of cells by filling the plate with water, and transferring heat from water within the plurality of cells to the mold cells and freezing water within the cells.

[0052] In one aspect of the disclosure, an ice making apparatus may be provided comprising a mold, wherein the mold may comprise a plurality of cells. Each cell may comprise an opening at a top of each cell. The mold may comprise a plurality of passageways for a cooling agent, and an upper part. The upper part may be hermetically enclosed with a cover. The upper part may comprise a vacuum chamber. A vacuum pump may be provided, the vacuum pump configured to pump wet air from the mold. A pipe may be provided, the pipe extending from the vacuum chamber of the mold to the vacuum pump. When pressure in the vacuum chamber starts to decrease, dissolved gases start to leave the bulk of water in each cell. The vacuum pump may be configured to pump wet air from the mold so that the pressure in the vacuum chamber drops below 61 0.5 Pa ((0.18 in Hg) at 32° F.).

[0053] In one aspect of the disclosure, an ice cube is provided. The ice cube may comprise a top face having an outer perimeter, a bottom face having an outer perimeter, and side faces. Each side face may include a corresponding outer perimeter, a corresponding top edge, and a corresponding bottom edge, the corresponding top edge of each side face being longer than the corresponding bottom edge, each side face extending inward from the corresponding top edge to the corresponding bottom edge. The top face, bottom face and side faces may define a first volume. In an embodiment, a three-dimensional shape may be provided, the three-dimensional shape located within the first volume. The three-dimensional shape may comprise a second volume. The second volume may be defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge. The bulge may extend upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape. The bulge may taper as it extends upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape. The ice cube may further define a third volume between the first volume and the second volume, the third volume comprising ice, and second volume comprising unfrozen liquid or air, or a combination of unfrozen liquid and air.

[0054] In an aspect, a cooling agent distribution apparatus may be provided. The cooling agent distribution apparatus may comprise an inlet, an outlet, and a distribution device. The inlet may be configured to receive a cooling agent. The distribution device may be configured to receive the cooling agent from the inlet. The distribution device may be configured to distribute cooling agent in a manner that the cooling agent provides substantially equal or even cooling to a plurality of molds that comprise a liquid to be cooled by the cooling agent.

[0055] In an aspect, an ice making machine may be provided that is configured to produce ice faster than conventional ice making machines. Conventional ice making apparatus, such as ice making apparatus used to make ice for beverage dispensers, typically have ice production cycles of about 10-15 minutes, i.e., about 4-6 cycles per hour. In an aspect of the present disclosure, an ice making machine may be provided that produces ice in less than 1 minute, i.e., more than 60 cycles per hour. In an aspect of the present disclosure, an ice making machine may be provided that produces ice in about 30 seconds, i.e., about 120 cycles per hour. In an aspect of the present disclosure, an ice making machine may be provided that produces ice in about 17 seconds or less, i.e., about 212 cycles per hour or more. In an aspect of the present disclosure, an ice making machine may be provided that produces ice in about 15 seconds, i.e., about 240 cycles per hour. The above 30 second and 17 second times are freezing times. Time is needed to fill cells with water, freeze it, disengage the ice from the mold, and to harvest the ice. Therefore, the production cycle is about 70-90 seconds, which includes a 30 second freezing time, and the production cycle is about 60-80 seconds, which includes a 17 second freezing time.

[0056] In an aspect, an ice making machine may be provided that comprises an ice harvesting apparatus. The ice harvesting apparatus may comprise various structures for facilitating removal of ice cubes from a mold. The ice harvesting apparatus may be configured to be incorporated into the ice making machine and/or cooperate with the ice making machine disclosed herein.

[0057] In an aspect of the disclosure, an ice making apparatus comprising a mold is provided. The apparatus comprises an arm and an ice cube mold comprising a plurality of ice cube mold cells. The ice cube mold is configured to cool a liquid in the ice cube mold cells sufficient such that an ice cube is formed in each ice cube mold cell. The apparatus comprises a water filling system, the water filling system configured to move along the arm. The water filling system comprises water filling dispensers. Each water filling dispenser is configured to dispense a liquid to be frozen into a corresponding ice cube mold cell. Each water filling dispenser is configured to move an ice cube formed in the corresponding ice cube mold cell away from the corresponding ice cube mold cell when the water filling system moves away from the ice cube mold. Moreover, the apparatus comprises an ice cube remover. The ice cube remover may be configured to push ice cubes off the water filling dispensers when the water filling system is moved along the arm toward the ice cube remover.

[0058] In an aspect of the disclosure, an ice making apparatus is configured to provide conditions for fast (on-demand) production. This is achieved by increased intensity of heat exchange between water and mold which is achieved by specially designed cells which increase the surface area of the water-mold interface.

[0059] FIG. **1**A illustrates an embodiment in accordance with aspects of the disclosure. More specifically, FIG. **1**A illustrates a shape of an of ice cube **100** with an increased area of mold-water interface. Ice cube **100** may be formed using a corresponding ice cube mold **126**. Ice cube **100** comprises a top face **102**, a bottom face **101**, and four side faces **105**, **106**, **107** and **108**. In an embodiment, the top face **102**, the bottom face **101**, and the four side faces **105**, **106**, **107**, and **108** may be parallelograms. Top face **102** may have an outer perimeter **112**, and bottom face **101** may have an outer perimeter **111**. Each of the four side faces **105**, **106**, **107**, and **108** may have an outer perimeter **114**. The outer perimeter **114** of each side face may have a top edge **116** and a bottom edge **118**. In an embodiment, the top edge **116** of each side face **105**, **106**, **107**, and **108** may be longer than bottom edge **118** of each side face **105**, **106**, **107**, and **108**. In an embodiment, each of the side faces **105**, **106**, **107** and **108** may extend or slant inward from the top edge **116** of each side face.

[0060] In an embodiment of the disclosure, a mold **126** is provided. Mold **126** may define a first volume for an ice cube, such as ice cube **100**. Mold **126** may comprise a bottom face having an inner perimeter. Mold **126** may also comprise side faces. Each side face of the mold may have a corresponding inner perimeter, a corresponding top edge, and a corresponding bottom edge. The corresponding top edge of each side face may be longer than the corresponding bottom edge, each side face extending inward from the corresponding top edge to the corresponding bottom edge. The bottom face and side faces of mold **126** may respectively correspond to the bottom face **101**, and side faces **105**, **106**, **107** and **108** of ice cube **100**. Mold **126** nay comprise a top face having an inner diameter. Top face of mold **126** may correspond to the top face **102** of ice cube **100**.

[0061] In an embodiment of the disclosure, a three-dimensional shape **122** is provided. In an embodiment, three-dimensional shape **122** may be generally a three-dimensional "U"-shape **120**. The U-shape **120** may have a top outer perimeter **103**, and a bottom outer perimeter **104**, and side fins **124**. In an embodiment, top outer perimeter **103** may be smaller than the bottom outer perimeter **104**. In an embodiment, side fins **124** may taper as they extend upwardly from the bottom outer perimeter **104** to top outer perimeter **103**.

[0062] FIGS. **1**B, **1**C, **1**D, and **1**E illustrate various views of ice cube **100**. FIG. **1**B is a perspective view of ice cube **100** after it has been removed from mold **126** shown in FIG. **1**A. Ice cube **100** may have the following dimensions: each top edge **116** may have length L**1** (see FIGS. **1**C and **1**D), each bottom edge **118** may have a length L**2** (see FIG. **1**D), and a length L**3** between a plane of the top face **102** and a plane of the bottom face **101** (see FIG. **1**D). In an embodiment, ice cube **100** may have inclined outer side walls and length L**1** may be greater than length L**2**. In an embodiment, length L**1** may be 21 mm, length L**2** may be 19 mm, and length L**3** may be 20 mm. As shown in FIG. **1**C, after the three-dimensional shape **122** is removed from ice cube **100**, a void **128** is defined by ice cube **100**. Void **128** may comprise legs **130** and **132**, which face each other, and a connecting portion **134** that is connected to each leg. In an embodiment, the distance D**1** between the legs **130** and **132** may be greater at the top face **102** than the distance D**2** at the bottom face **101**. For example, distance D**1** may be 5 mm, and distance D**2** may be 3 mm. Due to tapering of ice cube **100** between length L**1** and length L**2**, the difference in length between length L**1** and length L**2** is shown as distance D**3** at each end of length L**2**. In an embodiment, D**3** may be 1 mm.

[0063] FIGS. **1**F, **1**G, **1**H, and **1**I illustrate various views of an embodiment of an ice cube **100'**. In an embodiment shown in FIGS. **1**F through **1**I, length L**1** may be 23 mm, length L**2** may be 21 mm, length L**3** may be 22 mm, distance D**1** may be 5 mm, and distance D**2** may be 3 mm. Ice cube **100'** may have a similar shape as ice cube **100**, with different dimensions for L**1**, L**2** and/or L**3**. Due to tapering of ice cube **100'** between length L**1** and length L**2**, the difference in length between length L**1** and length L**2** is shown as distance D**3** at each end of length L**2**. In an embodiment, D**3** may be 1 mm.

[0064] FIGS. **1**J, **1**K, and **1**L illustrate an ice cube **150** having vertical walls. Ice cube **150** may have a void **152**. Ice cube **150** may have the following dimensions: each top edge **154** may have length L**1**, each bottom edge **156** may have a length L**2**, and a length L**3** between a plane of the top face **158** and a plane of the bottom face **160**. In an embodiment, length L**1** may be 20 mm, length L**2** may be 20 mm, and length L**3** may be 20 mm. As shown in FIG. **1**K, after a three-dimensional shape (not shown) that corresponds to void **152** is removed from ice cube **150**, void **152** is defined by ice cube **150**. The three-dimensional shape that corresponds to void **152** may have a shape similar to three-dimensional shape **122** discussed in connection with FIG. **1**A, but with vertical walls rather than inclined walls. Void **152** may comprise legs **162** and **164**, which face each other, and a connecting portion **166** that is connected to each leg. In an embodiment, the distance D**1** between the legs **162** and **164** may be 4 mm. Leg **162** may have a width W**1**, leg **164** may have a width W**2**, and connecting portion **166** may have a width W**3**. In an embodiment, W**1**, W**2**, and W**3** may each be 4 mm.

[0065] Ice cube **150** may be formed in accordance with the following procedure. An empty mold is cooled down from the bottom of the mold to about −30 to about −35 degrees. The mold is filled with room temperature water using a syringe. In about 30-35 seconds, ice cube **150** may be frozen to about 95% by volume, and 100% frozen in about 45 seconds. FIG. **8**A depicts the percentage by volume of ice cube **150** versus time.

[0066] An ice cube having the same dimensions as ice cube **150** is formed in accordance with the following procedure. An empty mold is cooled down from the bottom of the mold to about −30 to about −35 degrees Celsius. The mold is filled with room temperature water using a syringe. In about 17 seconds, unfrozen water may be sucked from the mold, leaving a layer of ice on the mold surfaces. The average wall thickness may be about 2 mm after 17 seconds of freezing. When the freezing time is extended to 30 seconds, the average wall thickness was about 3 mm. FIG. **8**B depicts the ice cube wall thickness in mm versus time.

[0067] FIG. **9**A depicts the portions of ice cube **150** that comprises water and the portion of ice cube **150** that comprises ice after 30 seconds of freezing in accordance with the above procedure. FIG. **9**B depicts temperature (in degrees Celsius) for ice cube **150** after 30 seconds of freezing in accordance with the procedure described above with respect to FIG. **8**A.

[0068] Ice cube **100** described in connection with FIGS. **1**B through **1**E may be formed in accordance with the following procedure. An empty mold is cooled down to about −35 degrees Celsius. The mold is filled with room temperature water using a syringe. FIG. **9**C depicts the portions of ice cube **100** that comprises water and the portion of ice cube **100** that comprises ice after 30 seconds of freezing in accordance with the above procedure. FIG. **9**D depicts temperature (in degrees Celsius) for ice cube **100** after 30 seconds of freezing in accordance with the procedure described above.

[0069] Ice cube **100'** described in connection with FIGS. **1**F through **1**I may be formed in accordance with the following procedure. An empty mold is cooled down to about −35 degrees Celsius. The mold is filled with room temperature water using a syringe. FIG. **9**E depicts the portions of ice cube **100'** that comprises water and the portion of ice cube **100** that comprises ice after 30 seconds of freezing in accordance with the above procedure. FIG. **9**F depicts temperature (in degrees Celsius) for ice cube **100** after 30 seconds of freezing in accordance with the procedure described above.

[0070] FIG. **2** shows an embodiment of an mold **200** in accordance with at least one aspect of the disclosure. Mold **200** may be configured to correspond to the ice cube depicted in FIG. **1**. Mold body **201** may include a plurality of individual ice cube mold cells **202**. Each mold cell may include fins **203** connected to the mold body **201**. Channels **204** for a cooling agent may be located in proximity to the cells **202** in order to provide efficient heat transfer to freeze water in the mold cells **202**.

[0071] In an aspect of the disclosure, using an ice cube shape as shown in FIG. **1** may result in about a 10-fold reduction of ice cube freezing time as compared to a monolithic cube of the same external dimensions.

[0072] Other embodiments in accordance with the disclosure are depicted in FIGS. **3**A, **3**B, and **3**C. As shown in FIGS. **3**A, **3**B, and **3**C, bulges and/or fins may have different shapes and may be configured to increase the area of the mold-surface interface.

[0073] FIG. **3**A illustrates a shape of an of ice cube **300** with an increased area of mold-water interface in accordance with at least one aspect of the disclosure. As shown in FIG. **3**A, ice cube **300** may have a top face **302**, a bottom face **301**, and side faces **305**, **306**, **307** and **308**. In an embodiment, top face **302**, bottom face **301**, and the four side faces **305**, **306**, **307**, and **308** may be parallelograms. Ice cube **300** may be formed using a corresponding ice cube mold, such as mold **126** shown in FIG. **1**. Top face **302** may have an outer perimeter **312**, and bottom face **301** may have an outer perimeter **311**. Each of the four side faces **305**, **306**, **307**, and **308** may have an outer perimeter **314**. The outer perimeter **314** of each side face may have a top edge **316**, and a bottom edge **318**. In an embodiment, the top edge **316** of each side face **305**, **306**, **307**, and **308** may be longer than the bottom edge **318** of each side face **305**, **306**, **307**, and **308**. In an embodiment, each of the side faces **305**, **306**, **307** and **308** may extend or slant inward from the top edge **316** of each side face. In an embodiment, a mold **320** is provided. Mold **320** may comprise a three-dimensional shape **322**. In an embodiment, three-dimensional shape **322** may be generally a three-dimensional truncated "M"-shape. Three-dimensional shape **322** may have a top outer perimeter **303**, a bottom outer perimeter **304**, and side fins **324**. In an embodiment, top outer perimeter **303** may be smaller than bottom outer perimeter **304**. In an embodiment, side fins **324** may taper as they extend upwardly from the bottom outer perimeter **304** to top outer perimeter **303**.

[0074] FIG. **3**B illustrates a shape of an of ice cube **340** with an increased area of mold-water interface in accordance with at least one aspect of the disclosure. As shown in FIG. **3**B, ice cube **340** may have a top face **342**, a bottom face **341**, and side faces **345**, **346**, **347** and **348**. In an embodiment, the top face **342**, the bottom face **341**, and the four side faces **345**, **346**, **347**, and **348** may be parallelograms. Ice cube **340** may be formed using a corresponding ice cube mold. Top face **342** may have an outer perimeter **352**, and bottom face **341** may have an outer perimeter **351**. Each of the four side faces **345**, **346**, **347**, and **348** may have an outer perimeter **354**. The outer perimeter **354** of each side face may have a top edge **356** and a bottom edge **358**. In an embodiment, the top edge **356** of each side face **345**, **346**, **347**, and **348** may be longer than the bottom edge **358** of each side face **345**, **346**, **347**, and **348**. In an embodiment, each of the side faces **345**, **346**, **347** and **348** may extend or slant inward from the top edge **356** of each side face. In an embodiment, a mold **360** is provided. Mold **360** may comprise a three-dimensional shape **362**. In an embodiment, three-dimensional shape **362** may be generally a set of three-dimensional "L"-shapes, with two of the three-dimensional L-shapes (**363**, **364**) being mirror images of each other. A third three-dimensional shape **365** may be positioned between and may join the three-dimensional L-shapes (**363**, **364**). The three-dimensional shape **362** may have a top outer perimeter **366**, a bottom outer perimeter **367**, and side fins **368**. In an embodiment, top outer perimeter **366** may be smaller than the bottom outer perimeter **367**. In an embodiment, side fins **368** may taper as they extend upwardly from the bottom outer perimeter **367** to top outer perimeter **366**.

[0075] FIG. **3**C illustrates a shape of an of ice cube **380** with an increased area of mold-water interface in accordance with at least one aspect of the disclosure. As shown in FIG. **3**C, ice cube **380** may have a top face **382**, a bottom face **381**, and side faces **385**, **386**, **387** and **388**. In an embodiment, the top face **382**, the bottom face **381**, and the four side faces **385**, **386**, **387**, and **388** may be parallelograms. Ice cube **380** may be formed using a corresponding ice cube mold. Top face **382** may have an outer perimeter **389**, and bottom face **381** may have an outer perimeter **390**. Each of the four side faces **385**, **386**, **387**, and **388** may have an outer perimeter **391**. The outer perimeter **391** of each side face may have a top edge **392** and a bottom edge **393**. In an embodiment, the top edge **392** of each side face **385**, **386**, **387**, and **388** may be longer than bottom edge **393** of each side face **385**, **386**, **387**, and **388**. In an embodiment, each of the side faces **385**, **386**, **387** and **388** may extend or slant inward from the top edge **392** of each side face. In an embodiment, a mold **394** may be provided. Mold **394** may comprise a three-dimensional shape **395**. In an embodiment, three-dimensional shape **395** may have a shape generally the same as ice cube **380**, but is smaller in size. In an embodiment, three-dimensional shape **395** may be an upside down mirror image of a reduced volume of ice cube **380**. Three-dimensional shape **395** may have top outer perimeter **396** and a bottom outer perimeter **397**. In an embodiment, top outer perimeter **396** may be smaller than the bottom outer perimeter **397**. In an embodiment, three-dimensional shape **395** may have side faces **398**. Side faces **398** may taper as they extend upwardly from the bottom outer perimeter **397** to top outer perimeter **396**.

[0076] An embodiment of a mold **400** is shown in FIG. **4** in accordance with various aspects of the disclosure. Mold **400** may comprise a first part **401** and a second part **402**. Each of the parts may have a plurality of ice cube mold cells **410**. The cells may be placed so that one cell on first part **401** and one cell on second part **402** form a single enclosure **403** to make a single ice cube. Enclosure **403** may be filled with water **411** through channel **405**. Channel **406** may allow air to escape from enclosure **403** when the latter is being filled with water **411**. Each part **401** and **402** of the mold may also include a plurality of passageways **409** for cooling agent **407**. In order to seal enclosures **403**, the first part **401** and/or the second part **402** may be covered with a sealing coating **408** at a surface area where the first part **401** meets the second part **402**.

[0077] FIG. **5** illustrates an ice cube configuration in accordance with aspects of the disclosure. Ice cube **500** may be used to reduce freezing time. In this configuration, ice cube **500** may have a shape of a truncated pyramid similar to a regular dice ice cube. Unlike a regular dice ice, however, ice cube **500** may define an internal volume **502** that is not completely frozen, thus providing a structure of ice cube walls **501**, which enclose internal volume **502** filled with water.

[0078] Because volume of ice in the ice cube **500** is significantly lower than that of a monolithic ice cube of the same exterior dimension, ice cube freezing time to form ice cube

500 may be about 20-fold less as compared to ice cube freezing time to form a monolithic cube of the same external dimensions.

[0079] FIG. **6** illustrates a mold design that may produce ice cube **500** illustrated in FIG. **5**. Mold **600** may comprise a mold **601** and a plate **602**. Mold **601** and plate **602** may each have a plurality of passageways **606** for a cooling agent (not shown). Mold **601** may also comprise a plurality of ice cube cells **603**. Each cell **603** may have a corresponding channel **605** to let air escape from the cell when plate **602** is filled with water **604**.

[0080] The freezing time may be chosen so that the resulting wall thickness of the ice cube may be sufficient to provide required mechanical strength of the ice cube. Because the volume of ice in ice cube **500** is significantly less than that of a monolithic ice cube of the same exterior dimension, the time needed to freeze the ice cube structure of ice cube **500**, i.e., ice cube walls **501**, may be reduced by a factor of about 20-fold for a wall thickness of about 2-3 mm.

[0081] An alternative approach for production of ice cubes is shown in FIG. **7** in accordance with at least one aspect of the disclosure. Ice making apparatus **700** may comprise a mold **701**. Mold **701** may comprise a plurality of cells **702** and a plurality of passageways **710** for a cooling agent **703**. In order to provide freezing of water surface at the open side **711** of cell **702**, water evaporation may be utilized. An upper part **712** of mold **701** may be hermetically enclosed with a cover **704**. Upper part **712** may be connected by a pipe **705** to a vacuum pump **706**, which may be configured to pump wet air from mold **701**.

[0082] As the pressure above water surface (e.g., in vacuum chamber **707**) starts to decrease, dissolved gases start to leave the bulk of water. When the pressure drops below the point of water vapor partial pressure (which is 61 0.5 Pa (0.18 in Hg) at 32° F.) water/ice start to intensively evaporate. This causes significant heat energy removal from the remaining liquid water.

[0083] FIGS. **10**A, **10**B, **10**C, and **10**D depict ice cube **1000**. As shown in these figures, ice cube **1000** may be formed using a three-dimensional shape **1002**. Three-dimensional shape **1002** may comprise vertical walls **1004**, and have a top face **1006** and a bottom face **1008** that are squares. Each outside wall **1010** of ice cube **1000** may be a square. Each outside wall **1010** may have a length L**1**. In an embodiment, length L**1** may be 20 mm. Each outside wall **1010** may have a width W**4**. In an embodiment, width W**4** may be 4 mm. The thickness or width of each outside wall **1010** may be 4 mm, and the void **1012** defined in ice cube **1000** after three-dimensional shape **1002** is removed, may have a distance of 12 mm between opposing inner faces **1014** and **1016** of ice cube **1000**.

[0084] Ice cube **1000** may be formed in accordance with the following procedure. An empty mold corresponding to the shape of ice cube **1000** may be cooled down to −35 degrees Celsius. The mold is filled with room temperature water using a syringe.

[0085] FIGS. **11**A, **11**B, **11**C, and **11**D depict ice cube **380** shown in FIG. **3**C. Three-dimensional shape **395** is shown in FIG. **11**C. Ice cube **380** may have the following dimensions: each top edge **392** may have length L**1**; each bottom edge **393** may have a length L**2**, and a length L**3** between a plane of the top face **382** and a plane of the bottom face **381**. In an embodiment, L**1** may be 21 mm, L**2** may be 19 mm, and L**3** may be 20 mm. As shown in FIG. **11**B, after the three-dimensional shape **395** is removed from ice cube **380**, a void **399** is defined by ice cube **380**. As discussed with respect to FIG. **3**C, in an embodiment, three-dimensional shape **395** may be an upside down mirror image of a reduced volume of ice cube **380**. Three-dimensional shape **395** may have top outer perimeter **396** and a bottom outer perimeter **397**. In an embodiment, top outer perimeter **396** may be smaller than the bottom outer perimeter **397**. In an embodiment, three-dimensional shape **395** may have side faces **398**. Side faces **398** may taper as they extend upwardly from the bottom outer perimeter **397** to top outer perimeter **396**. The width from void **399** to the top edge **392** may be a width W**5**. In an embodiment, width W**5** may be 5 mm. The width from void **399** to the bottom edge **393** may be a width W**6**. In an embodiment, width W**6** may be 3 mm. The difference in length between length L**1** and length L**2** is shown as distance D**3** at each end of length L**2**. In an embodiment, D**3** may be 1 mm.

[0086] FIGS. **12**A, **12**B, **12**C, and **12**D depict ice cube **1200**. Ice cube **1200** has rounded outside corners **1202**, but is otherwise similar to ice cube **380** shown in FIGS. **11**A, **11**B, **11**C, and **11**D.

[0087] FIGS. **13**A, **13**B, **13**C, and **13**D depict ice cube **1300**. Ice cube **1300** has a similar shape as ice cube **1200** shown in FIGS. **12**A, **12**B, **12**C, and **12**D, except that ice cube **1300** has different dimensions than ice cube **1200**. For example, in FIG. **13**A through **13**D, length L**1** may be 23 mm, length L**2** may be 21 mm, and length L**2** may be 22 mm. In FIG. **13**A through **13**D, width W**5** may be 5 mm, width W**6** may be 3 mm, and distance D**3** may be 1 mm.

[0088] FIG. **14** illustrates time to freeze 95% by volume and time to achieve complete freezing of ice cubes **150**, **100**, **100'**, **1000**, **380**, **1200**, and **1300** respectively.

[0089] FIG. **15**A, FIG. **15**B, FIG. **15**C and FIG. **15**D illustrate a cooling agent distribution apparatus **1500** in accordance with at least one aspect of the disclosure. Apparatus **1500** may comprise an inlet **1502**, an outlet **1504**, and a distribution device **1506**. Inlet **1502** may be configured to receive a flow of a cooling agent having a first temperature. Distribution device **1506** may be configured to receive the flow of the cooling agent from inlet **1502**. Apparatus **1500** may further comprise pan **1508**. Distribution device **1506** may be configured to distribute cooling agent in a manner that the cooling agent provides substantially equal or even cooling to a plurality of molds **1512** that may comprise a liquid to be cooled by the cooling agent. Distribution device **1506** may comprise a pan **1508** and a distribution body **1510**. Body **1510** may be configured to receive the flow of cooling agent from inlet **1502**. Pan **1508** may be configured to receive the flow of cooling agent from body **1510** as the cooling agent flows from body **1510**, and cools a plurality of molds **1512** as the cooling agent flows through pan **1508** to outlet **1504**. The cooling agent may have a second temperature at outlet **1504**. The second temperature of the cooling agent at outlet **1504** may be different than the first temperature of the cooling agent at the inlet **1502**. For example, the second temperature of the cooling agent at outlet **1504** may be higher than the first temperature of the cooling agent at inlet **1502**.

[0090] Distribution device **1506** may comprise any suitable combination of pan shape and body shape for distribution of cooling agent in pan **1508** to provide substantially equal or even cooling to a plurality of molds **1512** that may comprise a liquid to be cooled by the cooling agent. As shown in FIG. **15**B, FIG. **15**C, and FIG. **15**D, distribution device **1506** may comprise a body or tube **1510** may be elongated. Body **1510**

may be bar-shaped. Body **1510** may comprise a first section **1514**, a second section **1516**, and a third section **1518**. First section **1514** may be closer to inlet **1502** than the second section **1516**, and second section **1516** may be closer to inlet **1502** than the third section **1518**. Second section **1516** may be closer to outlet **1504** than first section **1514**. Third section **1518** may be closer to outlet **1504** than first section **1514** and second section **1516**. Thus, second section **1516** may be a middle section that is between first section **1514** and third section **1518**. In an embodiment, body **1510** may lie on a surface **1542** of pan **1508**. In another embodiment, body **1510** may extend over but not lie on surface **1542** of pan **1508**. As shown in FIGS. **15**B, **15**C, and **15**D, body **1510** may have a length, width and height that is each less than a corresponding length, width, and height of the pan **1508**.

[0091] In an embodiment, body **1510** may comprise a first end **1520**, a second end **1522**, a top surface **1524** and a bottom surface **1526**, the bottom surface **1526** opposite the top surface **1524**. Bottom surface **1526** of body **1510** may lie on surface **1542** of pan **1508**. Body **1510** may comprise a first side surface **1528**, and a second side surface **1530**, the second side surface **1530** opposite the first side surface **1528**. First end **1520** may be in fluid communication with inlet **1502**. Second end **1522** may be at an end of third section **1518**.

[0092] First section **1514** may define a first set of holes **1532**. First set of holes **1532** may comprise two holes at first side surface **1528**, and two holes at second side surface **1530**, the two holes at second side surface **1530** opposite the two holes at first side surface **1528**.

[0093] Second section **1516** may define a second set of holes **1534**. Second set of holes **1534** may comprise one hole at top surface **1524**, one hole at first side surface **1528**, and one hole at second side surface **1530**.

[0094] Third section **1518** may define a third set of holes **1536**. Third set of holes **1536** may comprise two holes at top surface **1524**, three holes at first side surface **1528**, and three holes at second side surface **1530**.

[0095] FIG. **15**D illustrates arrows that shows the flow of a cooling agent from the first, second, and third sets of holes and into pan **1508**. Pan **1508** may have an end **1538**. End **1538** may define one or more holes **1540**. Hole(s) **1540** may be a plurality of holes, as shown in FIG. **15**D. As shown in FIG. **15**D, flow of a cooling agent may exit pan **1508** through hole(s) **1540** and into outlet **1504**. In an alternative to hole(s) **1540** or in addition to hole(s) **1540**, end **1538** may comprise a funnel or frusto-conical shape configured to receive flow of a cooling agent from pan **1508** and convey the flow of the cooling agent to outlet **1504**.

[0096] Those of skill in the art will recognize that, in accordance with the disclosure, as cooling agent flows from body **1510** and into pan **1508**, and then flows towards outlet **1504**, the cooling agent will cool liquid that may be placed in the plurality of molds **1512** by removing heat from the liquid. Those of skill in the art will recognize that, in accordance with the disclosure, the placement, number, and sizing of each of the holes of the first, second, and third sets of holes may be varied to distribute cooling agent in a manner that the cooling agent provides substantially equal or even cooling to a plurality of molds **1512** that may comprise a liquid to be cooled by the cooling agent. Those of skill in the art will recognize that, in accordance with the disclosure, the equal or even cooling of the liquid in the plurality of molds may result in liquid in each mold freezing at about the same rate, thereby forming an ice cube in each mold at about the same time.

[0097] Those of skill in the art will recognize that, in accordance with the disclosure, cooling agent distribution apparatus **1500** and/or distribution device **1506** may be used in for the making of ice cubes, such as the ice cubes disclosed herein, e.g., ice cube **100** (shown in FIGS. **1**A through **1**E), ice cube **100'** (shown in FIG. **1**F through **1**I), ice cube **150** (shown in FIGS. **1**J through **1**K), ice cubes formed in ice cube mold cells **202** (FIG. **2**), ice cube **300** (shown in FIG. **3**A), ice cube **340** (shown in FIG. **3**B), ice cube **380** (shown in FIG. **3**C, and FIGS. **11**A through **11**D), ice cubes formed in ice cube mold cells (see FIG. **4**), ice cube **500** (see FIG. **5**), ice cubes formed in ice cube mold cells **603** (see FIG. **6**), ice cubes formed in ice cube mold cells **702** (see FIG. **7**), ice cube **1000** (shown in FIGS. **10**A through **10**D), ice cube **1200** (shown in FIGS. **12**A through **12**D), and ice cube **1300** (shown in FIGS. **13**A through **13**D).

[0098] Apparatus **1500** may also be used to facilitate removal of ice cubes from molds **1512**. For example, after ice cubes have been formed in molds **1512**, the flow of the cooling agent may be stopped, and a flow of a warming agent, also called a hot cooling agent, may be sent through the same pathway as the cooling agent, i.e., the warming agent may be sent through inlet **1502**, distribution device **1506**, pan **1508**, and outlet **1504**. The warming agent may have a first temperature at inlet **1502**, and a second temperature at outlet **1504**. The second temperature of the warming agent at outlet **1504** may be different than the than the first temperature of the warming agent at inlet **1502**. For example, the second temperature of the warming agent at outlet **1504** may be lower than the first temperature of the warming agent at inlet **1502**. As the warming agent flows through pan **1508**, the warming agent heats the ice-mold interface, thereby loosening the ice cubes from molds **1512**.

[0099] The ice harvesting apparatus may comprise two molds. Each mold may comprise a plurality of mold cells. The two molds may be anti-phase and rotational with respect to each other.

[0100] FIG. **16**A and FIG. **16**B illustrate a mold device **1600** that may comprise back-to-back ice cube molds **1602** and **1604**. FIG. **16**A is a perspective view of mold device **1600** when assembled. FIG. **16**B is an exploded view of mold device **1600** shown in FIG. **16**A. Mold **1602** may comprise a first plurality of mold cells **1606**, e.g., forty-five mold cells, on one side of the mold **1602**, and a first heat transfer device **1610** on an opposite side of the first plurality of mold cells **1606**. Mold **1604** may comprise a second plurality of mold cells **1608**, e.g., forty-five mold cells, on one side of mold **1604**, and a second heat transfer device **1612** on an opposite side of the second plurality of mold cells **1608**.

[0101] Mold device **1600** may comprise a first subassembly **1614**. First subassembly **1614** may comprise mold **1602**, a first mold cover **1616**, a first heat transfer device **1610**, and a first heat transfer device cover **1618**. First mold cover **1616** may comprise a thermally insulated cover and/or comprise thermally insulated material. First mold cover **1616** may define a first opening **1634**. First mold cover **1616** may be configured so that when it is placed over mold **1602**, first opening **1634** allows for the plurality of mold cells **1606** to be filled with a liquid, e.g., water, when mold **1602** is in an upwardly facing position. Mold **1602** may be configured so that first heat transfer device **1610** may be placed in compartment **1636** of first heat transfer device cover **1618**.

[0102] Mold device **1600** may comprise a second subassembly **1620**. Second subassembly **1620** may comprise mold

1604, a second mold cover 1622, a second heat transfer device 1612, and a second heat transfer device cover 1624. Second mold cover 1622 may define a second opening 1640. Second mold cover 1624 may be configured so that when it is placed over mold 1604, second opening 1640 allows for the plurality of mold cells 1608 to be filled with a liquid, e.g., water, when mold 1604 is in an upwardly facing position. Mold 1604 may be configured so that second heat transfer device 1612 may be placed in compartment 1642 of second heat transfer device cover 1624.

[0103] Mold device 1600 may comprise a housing 1626. Housing 1626 may be thermally insulated and/or comprise thermally insulated material. Mold device 1600 may comprise inlet cooling agent tubes 1628, outlet cooling tubes 1628', shaft 1630 and shaft supports 1632. Inlet cooling agent tubes 1628 and outlet cooling agent tubes 1628' may be flexible. Inlet cooling agent tubes 1628 may be configured to supply a cooling agent to at least the first heat transfer device 1610 when the first heat transfer device 1610 is in an upwardly facing position, or supply a cooling agent to at least the second heat transfer device 1612 when the second heat transfer device 1612 is in an upwardly facing position. Shaft 1630 may be supported by shaft supports 1632. Shaft 1630 may be configured to rotate about an axis A-A so that first subassembly 1614 and the second subassembly 1620 may change positions. For example, the first subassembly 1614 may be rotated from an upwardly facing position as shown in FIG. 16A to a downwardly facing position, and the second subassembly 1620 may be rotated from a downwardly facing position as shown in FIG. 16B to an upwardly facing position.

[0104] First subassembly 1614 and second subassembly 1620 may be back-to-back when placed in housing 1626. In other words, a back 1644 of the first heat transfer device 1618 may face a back 1646 of the second heat transfer device cover 1624.

[0105] Those of skill in the art will recognize that in accordance with the disclosure, the first heat transfer device 1610 and second heat transfer device 1612 may be any suitable heat transfer device, including but not limited to a heat transfer device comprising cooling fins 1648.

[0106] FIG. 17A and FIG. 17B illustrate mold 1602 in combination with first heat transfer device 1610 and first heat transfer device cover 1618. FIG. 17A is a perspective of the combination, and FIG. 17B is an exploded view of the combination. Dividers 1650 may be used at each end of first heat transfer device cover 1618. Dividers 1650 may be configured to obtain a desired flow of a cooling agent from an inlet tube 1628 (see FIG. 16B) to the first heat transfer device 1610 and from the first heat transfer device 1610 to an outlet tube 1628' (see FIG. 16B). As shown in FIG. 16B, mold 1604, second heat transfer device 1612, and second heat transfer device cover 1624 may have a similar or the same configuration as that of mold 1602, first heat transfer device 1610, and first heat transfer device cover 1618, respectively.

[0107] FIG. 18A illustrates a side view of mold 1602 and first heat transfer device 1610 previously described. FIG. 18B is a bottom view of the first heat transfer device 1610. Mold 1604 and second heat transfer device 1612 may have a similar or the same configuration as that of mold 1602 and first heat transfer device 1610, respectively. Cooling fins 1648 may have a radius R1 as shown in FIG. 18A. As shown in FIG. 18A, the dimensions of mold 1602 and first heat transfer device 1610 are depicted as distances A, B, C. Distance A is the height of cooling fins 1648. Distance B is the height of first heat transfer device 1610. Distance C is the height of the combination of mold 1602 and first heat transfer device 1610.

[0108] FIG. 19 illustrates a top view of first heat transfer device cover 1618 as previously described. Second heat transfer device cover 1624 may have a similar or the same configuration.

[0109] FIG. 20A, FIG. 20B, and FIG. 20C illustrate the first subassembly 1614 when placed in housing 1626. FIG. 20A is a perspective view, FIG. 20B is an exploded view, and FIG. 20C is a top view. Clips 2002 may be used to maintain the position of first subassembly in housing 1626. Second subassembly 1620 when placed in housing 1626 may have a similar or the same configuration as that of first subassembly 1614.

[0110] FIG. 21 illustrates mold device 1600 in a full assembly cross section view.

[0111] FIG. 22A illustrates a top perspective view of a mold 1602. FIG. 22B illustrates a bottom perspective view of mold 1602.

[0112] FIGS. 23A, 23B, 23C, 23D, 23E, 23F, 23G, and 23H illustrate various ice harvesting procedures, each of which may be used to harvest a plurality of ice cubes.

[0113] FIG. 23A illustrates ice harvesting procedure 2310. The following is a description of procedure 2310. In step 2311 of procedure 2310, water in a mold 2300 undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step 2311 may be about 30 seconds. The freezing of water to form ice cubes in step 2311 may be achieved by passing a cooling agent 2302 through channels 2304. Channels 2304 may be the same or similar to channels 204 previously described with respect to FIG. 2, or passageway 409 previously described with respect to FIG. 4. Mold 2300 may have a similar or same configuration as that of mold 1602, previously described. In step 2312 of procedure 2310, mold 2300 is rotated, e.g., rotated 180 degrees, so that the top 2317 of the ice cubes 2315 face down. Also in step 2312, a warming agent 2314, also called a hot cooling agent, may be used to heat mold 2300 to allow the ice cubes 2315 to be loosened from mold 2300. The warming agent 2314 may be passed through channels 2304. The passing of the warming agent 2314 through channels 2304 may occur during or shortly after rotation of mold 2300. In step 2313 of procedure 2310, ice cubes 2315 may be removed from mold 2300 by using gravity, and a harvest assist rod 2303. In step 2313, removal of ice cubes 2315 from mold 2300 may be facilitated by passing of the warming agent 2314 through channels 2304.

[0114] FIG. 23B illustrates ice harvesting procedure 2320. The following is a description of procedure 2320. In step 2321 of procedure 2320, water in a mold 2300 undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step 2321 may be about 30 seconds. The freezing of water to form ice cubes in step 2321 may be achieved by passing a cooling agent 2302 through channels 2304. Channels 2304 may be the same or similar to channels 204 previously described with respect to FIG. 2, or passageway 409 previously described with respect to FIG. 4. Mold 2300 may have a similar or same configuration as that of mold 1602, previously described. In step 2322 of procedure 2320, mold 2300 is rotated, e.g., rotated 180 degrees, so that the top 2317 of the ice cubes 2315 face down. In step 2323 of procedure 2320, a thin electric heater 2306 may be used to heat mold 2300 to loosen the ice cubes 2315 from mold 2300. Thin electric heater 2306 may surround or be at each ice-mold interface. Also in step 2323 of procedure 2320, ice cubes 2315 may be removed from mold **2300** by using gravity, and a harvest assist rod **2303**. Procedure **2320** may provide quick heating of the ice-mold interface.

[0115] FIG. **23**C illustrates ice harvesting procedure **2330**. The following is a description of procedure **2330**. In step **2331** of procedure **2330**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2331** may be about 30 seconds. The freezing of water to form ice cubes in step **2331** may be achieved by passing a cooling agent **2302** through channels **2304**. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. In step **2332** of procedure **2330**, mold **2300** is rotated, e.g., rotated 180 degrees, so that the top **2317** of the ice cubes **2315** face down. In step **2333** of procedure **2330**, a light source **2335** is turned on, and light emitted from light source **2335** is absorbed by light absorbing coating **2334** on mold **2300**, thereby heating mold **2300** to loosen the ice cubes **2315** from mold **2300**. Also in step **2333** of procedure **2330**, ice cubes **2315** may be removed from mold **2300** by using gravity, and a harvest assist rod **2303**. Procedure **2330** may provide quick heating of the ice-mold interface.

[0116] FIG. **23**D illustrates ice harvesting procedure **2340**. The following is a description of procedure **2340**. In step **2341** of procedure **2340**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2341** may be about 30 seconds. The freezing of water to form ice cubes in step **2341** may be achieved by passing a cooling agent **2302** through channels **2304**. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. In step **2342** of procedure **2330**, mold **2300** is rotated, e.g., rotated 180 degrees, so that the top **2317** of the ice cubes **2315** face down. In step **2343** of procedure **2340**, low adhesion coating **2344** on mold **2300** in combination with gravity permits the ice cubes **2315** to loosen from mold **2300**. Also in step **2343** of procedure **2340**, ice cubes **2315** may be removed from mold **2300** by using gravity, and a harvest assist rod **2303**. By using low adhesion coating **2344**, the need for heating of the ice-mold interface may be reduced or eliminated.

[0117] FIG. **23**E illustrates ice harvesting procedure **2350**. The following is a description of procedure **2350**. In step **2351** of procedure **2350**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2331** may be about 30 seconds. The freezing of water to form ice cubes in step **2351** may be achieved by passing a cooling agent **2302** through channels **2304**. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. Prior to freezing, extractors **2355** may be placed in the water that will be frozen to form the ice cubes. In step **2352** of procedure **2350**, mold **2300** may be heated using a warming cooling agent **2314** that is passed through channels **2304**, thereby allowing the ice cubes **2315** to loosen from mold **2300**. In step **2353** of procedure **2350**, the ice cubes **2315** may be removed from mold **2300** by raising extractors **2355**, as shown by the arrow in FIG. **23**E, and/or lowering mold **2300** away from extractors **2355** (not shown by an arrow). Extractors **2355** may be on extractor bar **2356**. In step **2353**, removal of ice cubes **2315** from mold **2300** may be facilitated by passing of the warming agent **2314** through channels **2304**. In step **2354** of procedure **2350**, the ice cubes **2315** may be released from extractors **2355** by heating the extractors **2355**.

[0118] FIG. **23**F illustrates ice harvesting procedure **2360**. The following is a description of procedure **2360**. In step **2361** of procedure **2360**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2361** may be about 30 seconds. The freezing of water to form ice cubes in step **2361** may be achieved by passing a cooling agent **2302** through channels **2304**. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. Prior to freezing, extractors **2355** may be placed in the water that will be frozen to form the ice cubes. In step **2362** of procedure **2360**, quick heating of the ice-mold interface may be achieved using a thin film electric heater **2306**, thereby allowing the ice cubes **2315** to loosen from mold **2300**. Thin electric heater **2306** may surround or be at each ice-mold interface. In step **2363** of procedure **2360**, the ice cubes **2315** may be removed from mold **2300** by raising extractors **2355** as shown by the arrow in FIG. **23**F, and/or lowering mold **2300** away from extractors **2355** (not shown by an arrow). Extractors **2355** may be on extractor bar **2356**. In step **2364** of procedure **2360**, the ice cubes **2315** may be released from extractors **2355** by heating the extractors **2355**.

[0119] FIG. **23**G illustrates ice harvesting procedure **2370**. The following is a description of procedure **2370**. In step **2371** of procedure **2370**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2371** may be about 30 seconds. The freezing of water to form ice cubes in step **2371** may be achieved by passing a cooling agent **2302** through channels **2304**. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. Prior to freezing, extractors **2355** may be placed in the water that will be frozen to form the ice cubes. In step **2372** of procedure **2370**, quick heating of the ice-mold interface may be achieved using a light source **2335**. The light emitted from light source **2335** may be absorbed by light absorbing coating **2334**, thereby allowing the ice cubes **2315** to loosen from mold **2300**. In step **2373** of procedure **2370**, the ice cubes **2315** may be removed from mold **2300** by raising extractors **2355** as shown by the arrow in FIG. **23**G, and/or lowering mold **2300** away from extractors **2355** (not shown by an arrow). Extractors **2355** may be on extractor bar **2356**. In step **2374** of procedure **2370**, the ice cubes **2315** may be released from extractors **2355** by heating the extractors **2355**.

[0120] FIG. **23**H illustrates ice harvesting procedure **2380**. The following is a description of procedure **2380**. In step **2381** of procedure **2380**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2381** may be about 30 seconds. The freezing of water to form ice cubes in step **2381** may be achieved by passing a cooling agent **2302** through channels

2304. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. Prior to freezing, extractors **2355** may be placed in the water that will be frozen to form the ice cubes. In step **2382** of procedure **2380**, the ice cubes **2315** may be removed from mold **2300** by raising extractors **2355** as shown by the arrow in FIG. 23H, and/or lowering mold **2300** away from extractors **2355** (not shown by an arrow). Extractors **2355** may be on extractor bar **2356**. The removal of the ice cubes **2315** from mold **2300** may be assisted by using a low adhesion coating **2344**. Low adhesion coating **2344** on mold **2300** as shown in FIG. 23H, in combination with movement of extractors **2355** away from mold **2300** permits the ice cubes **2315** to loosen from mold **2300**. By using low adhesion coating **2344**, the need for heating of the ice-mold interface may be reduced or eliminated. In step **2383** of procedure **2380**, the ice cubes **2315** may be released from extractors **2355** by heating the extractors **2355**. FIGS. 24A, 24B, 24C, 24D, and 24E, illustrate various ice harvesting procedures, each of which may be used to harvest a plurality of ice cubes.

[0121] FIG. 24A illustrates ice harvesting procedure **2410**. The following is a description of procedure **2410**. In step **2411** of procedure **2410**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2411** may be about 17 seconds. The freezing of water to form ice cubes in step **2411** may be achieved by passing a cooling agent **2302** through channels **2304**. Mold **2300** may comprise a first set of channels **2408** of channels **2304** below the bottom of ice cubes to be formed. A second set of channels **2409** of channels **2304** may also be provided above the top of the ice cubes to be formed. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. In step **2412** of procedure **2410**, mold **2300** is rotated, e.g., rotated 180 degrees, so that the top of the ice cubes face down. Prior to or after rotation in step **2412**, the second set of channels **2409** may be removed away from the ice cubes **2315**. As shown in step **2412**, removal of a plate **2419** comprising the second set of channels **2409** away from the ice cubes **2315** may be facilitated by passing a warming agent **2314** through channels **2304** of the second set of channels **2409**. In step **2412**, a warming agent **2314**, also called a hot cooling agent, may be used to heat mold **2300** to allow the ice cubes **2315** to be loosened from mold **2300**. The warming agent may be passed through channels **2304** of the first set **2408** of channels. The passing of the warming agent through channels **2304** of the first set **2408** of channels may occur during or shortly after rotation of mold **2300**. In step **2413** of procedure **2410**, ice cubes **2315** may be removed from mold **2300** by using gravity, and a harvest assist rod **2303**. In step **2413**, removal of ice cubes **2315** from mold **2300** may be facilitated by passing of the warming agent **2314** through channels **2304** of the first set of channels **2408**.

[0122] FIG. 24B illustrates ice harvesting procedure **2420**. The following is a description of procedure **2420**. In step **2421** of procedure **2420**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2421** may be about 17 seconds. The freezing of water to form ice cubes in step **2421** may be achieved by passing a cooling agent **2302** through channels **2304**. Mold **2300** may comprise a first set of channels **2408** of channels **2304** below the bottom of ice cubes to be formed. A second set of channels **2409** of channels **2304** may also be provided above the top of the ice cubes to be formed. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. In step **2422** of procedure **2420**, mold **2300** is rotated, e.g., rotated 180 degrees, so that the top of the ice cubes face down. Prior to or after rotation in step **2422**, the second set of channels **2409** may be removed from the ice cubes **2315**. As shown in step **2422**, removal of the second set of channels **2409** away from the ice cubes **2315** may be facilitated using a portion **2307** of a thin electric heater **2306**. In step **2422**, a thin electric heater **2306** may be used to heat mold **2300** to loosen the ice cubes **2315** from mold **2300**. Thin electric heater **2306** may surround or be at each ice-mold interface. Alternatively, or in addition to heating in step **2422**, heater **2306** may be used in step **2423** of procedure **2420** to loosen the ice cubes **2315** from mold **2300**. In step **2423**, ice cubes **2315** may be removed from mold **2300** by using gravity, and a harvest assist rod **2303**. Procedure **2420** may provide quick heating of the ice-mold interface.

[0123] FIG. 24C illustrates ice harvesting procedure **2430**. The following is a description of procedure **2430**. In step **2431** of procedure **2430**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2431** may be about 17 seconds. The freezing of water to form ice cubes in step **2431** may be achieved by passing a cooling agent **2302** through channels **2304**. Mold **2300** may comprise a first set of channels **2408** of channels **2304** below the bottom of ice cubes to be formed. A second set of channels **2409** of channels **2304** may also be provided above the top of the ice cubes to be formed. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. In step **2432** of procedure **2430**, mold **2300** is rotated, e.g., rotated 180 degrees, so that the top **2317** of the ice cubes **2315** face down. Prior to or after rotation in step **2432**, the second set of channels **2409** may be removed away from the ice cubes **2315**. In step **2432** of procedure **2430**, low adhesion coating **2344** on mold **2300** in combination with gravity permits the ice cubes to loosen from mold **2300**. In step **2433** of procedure **2430**, removal of ice cubes **2315** from mold **2300** may be facilitated by heating the mold **2300**, thereby decreasing the time of harvesting of ice cubes. In step **2433**, a warming agent **2314**, also called a hot cooling agent, may be used to heat mold **2300** to allow the ice cubes to be loosened from mold **2300**. The warming agent **2314** may be passed through channels **2304** of the first set of channels **2408**.

[0124] FIG. 24D illustrates ice harvesting procedure **2440**. The following is a description of procedure **2440**. In step **2441** of procedure **2440**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2441** may be about 17 seconds. The freezing of water to form ice cubes in step **2441** may be achieved by passing a cooling agent **2302** through channels **2304**. Mold **2300** may comprise a first set of channels **2408** of channels **2304** below the bottom of ice cubes to be formed. A second set of channels **2409** of channels **2304** may also be provided above the top of the ice cubes to be formed. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. In step **2442** of procedure **2440**, mold **2300** is rotated, e.g., rotated 180 degrees, so that the tops **2317** of the ice cubes **2315** face down. Prior to or after rotation in step **2442**, the second set of channels **2409** may be removed away from the ice cubes **2315**. In step **2443** of procedure **2440**, a thin electric heater **2306** may be used to heat mold **2300** to loosen the ice cubes from mold **2300**. Thin electric heater **2306** may surround or be at each ice-mold interface. Also in step **2443** of procedure **2440**, ice cubes may be removed from mold **2300** by using gravity. Removal of ice cubes may be facilitated by also using a harvest assist rod (not shown in FIG. 24D), such as harvest assist rod **2303**, previously discussed. Procedure **2440** may provide quick heating of the ice-mold interface.

[0125] FIG. **24**E illustrates ice harvesting procedure **2450**. The following is a description of procedure **2450**. In step **2451** of procedure **2450**, water in a mold **2300** undergoes freezing, with the top of the top face of ice cubes being formed facing up. This freezing in step **2451** may be about 17 seconds. The freezing of water to form ice cubes in step **2451** may be achieved by passing a cooling agent **2302** through channels **2304**. Mold **2300** may comprise a first set of channels **2408** of channels **2304** below the bottom of ice cubes to be formed. A second set of channels **2409** of channels **2304** may also be provided above the top of the ice cubes to be formed. Channels **2304** may be the same or similar to channels **204** previously described with respect to FIG. **2**, or passageway **409** previously described with respect to FIG. **4**. Mold **2300** may have a similar or same configuration as that of mold **1602**, previously described. In step **2452** of procedure **2450**, mold **2300** is rotated, e.g., rotated 180 degrees, so that the tops **2317** of the ice cubes **2315** face down. Prior to or after rotation in step **2452**, the second set of channels **2409** may be removed away from the ice cubes **2315**. The removal of the second set of channels **2409** may be facilitated by using a low adhesion coating **2344** at the ice-mold interface at the tops **2317** of ice cubes, and the second set of channels **2409**. In step **2453** of procedure **2450**, low adhesion coating **2344** on mold **2300** in combination with gravity permits the ice cubes **2315** to loosen from mold **2300**. Also in step **2453** of procedure **2450**, ice cubes **2315** may be removed from mold **2300** by using gravity, and a harvest assist rod **2303**. By using low adhesion coating **2444** in procedure **2450**, the need for heating of the ice-mold interface may be reduced or eliminated.

[0126] FIG. **25** illustrates ice harvesting procedure **2500**. The following is a description of procedure **2500**. Two back-to-back molds **2502** and **2504** may be provided. Molds **2502** and **2504** may each comprise 45 cube molds. Molds **2502** and **2504** may be the same or similar to molds **1602** and **1604** previously described. Mold device **1600**, previously described, may comprise molds **2502** and **2504**. Mold device **1600** may be used to perform procedure **2500**. Each of molds **2502** and **2504** may be used to produce 45 ice cubes every 40 seconds, which corresponds to 1.4 pounds of ice cubes per minute. Molds **2502** and **2504** in combination provide an 80 second ice cube production cycle, which includes freezing and harvesting of 90 ice cubes from molds **2502** and **2504**, collectively.

[0127] In step **2511** of procedure **2500**, water is filled into the cube molds **2506** of mold **2502**. During step **2511**, cooling of mold **2502** may be achieved by passing a cooling agent **2302** through channels **2304**. During step **2511**, heating of mold **2504** may begin to loosen ice cubes previously frozen in cube molds **2508** of mold **2504**. Heating of mold **2504** may occur by passing a warming agent **2314** through channels **2305** of mold **2504**. Step **2511** may take about 10 seconds.

[0128] After water is filled into cube molds **2506** of mold **2502** in step **2511**, step **2512** may then be conducted. In step **2512**, cooling of mold **2502** may continue by continuing to pass cooling agent **2302** through channels **2304**, thereby beginning of freezing the water in cube molds **2506**. In step **2512**, heating of mold **2504** may continue by continuing to pass the warming agent **2314** through channels **2305** of mold **2504**. Heating of mold **2504**, in combination gravity and using a harvest assist rod **2303** to knock or push ice cubes from cube molds **2506**, results in a harvesting of ice cubes **2550** from mold **2504** in step **2512**. Step **2512** may take about 20 seconds.

[0129] In step **2513**, cooling of mold **2502** may continue by continuing to pass cooling agent **2302** through channels **2304**, thereby continuing to freeze the water in cube molds **2506**. In step **2513**, cooling of mold **2504** may begin by passing cooling agent **2302** through channels **2305**. Step **2513** may take about 10 seconds.

[0130] In step **2514**, molds **2502** and **2504** are rotated 180 degrees so that mold **2502** and corresponding channels **2304** take the place of mold **2504** and corresponding channels **2305**. Procedure **2500** may be repeated, beginning with cube molds **2508** of mold **2504** being filled with water instead of cube molds **2506** of mold **2502** in accordance with step **2511**, and beginning of heating of mold **2502** (to loosen ice cubes previously frozen in cube molds **2506** of mold **2502** in step **2513**), e.g., heating mold **2502** by passing warming agent **2314** through channels **2304**.

[0131] FIG. **26** illustrates ice harvesting procedure **2600**. The following is a description of procedure **2600**. Two molds **2602** and **2604** may be provided. Molds **2602** and **2604** may each comprise 45 cube molds. Molds **2602** and **2604** may be the same or similar to molds **1602** and **1604** previously described. Mold device **1600**, previously described, may comprise molds **2602** and **2604**. Mold device **1600** may be used to perform procedure **2600**. Each of molds **2602** and **2604** may be used to produce 45 ice cubes every 40 seconds, which corresponds to 1.4 pounds of ice cubes per minute. Molds **2602** and **2604** in combination provide an 80 second ice cube production cycle, which includes freezing and harvesting of 90 ice cubes from molds **2602** and **2604**, collectively.

[0132] In step **2611** of procedure **2600**, water is filled into the cube molds **2606** of mold **2602**. Water may be filled using water filling needles **2620**. Cooling of mold **2602** may also occur during step **2611**. During step **2611**, cooling of mold **2602** may also occur by passing a cooling agent **2302** through channels **2304**. During step **2611**, mold **2604** may be heated to loosen ice cubes **2640** previously formed in mold **2604**. For example, this heating may be performed as shown in step **2611** of FIG. **26** by passing a warming agent **2314** through channels **2304** of mold **2604**, or by using a thin film electric heater, e.g., thin film electric heater **2306** as discussed in connection with FIGS. **23**B, FIG. **24**B, and **24**D, or by using a light absorbing coating **2332** and light source **2335** as discussed in connection with FIGS. **23**C and **23**G.

[0133] In step **2612**, cooling of mold **2602** continues to freeze the water in mold **2602**. During step **2612**, extractor bar **2656** may be moved away from mold **2604**, thereby moving water filling needles **2630** and ice cubes **2640** away from mold **2604**. Moving of ice cubes **2640** away from mold **2604** may be facilitated by continuing to heat mold **2604**, thereby heating the ice-mold interface.

[0134] In step **2613**, cooling of mold **2602** continues to freeze the water in mold **2602**. During step **2613**, extractor bar **2656** may be moved towards ice cube remover **2650**. Ice cube remover **2650** may be a rod or bar. When ice cubes **2640** come into contact with ice cube remover **2650**, ice cube remover **2650** knocks or pushes ice cubes **2640** off of water filling needles **2630**. During step **2613**, cooling agent **2302** may begin to be passed through channels **2304** of mold **2604** in order to begin to cool mold **2604**.

[0135] Step **2614** is the mirror image of step **2611**. During step **2614**, extractor bar **2656** is returned back to mold **2604** and water filling needles **2630** begin to fill mold **2604** with water. During step **2614**, mold **2602** may be heated to loosen ice cubes **2660** previously formed in mold **2602**. Heating of mold **2602** during step **2614** may be similar to heating of mold **2604** as previously discussed in connection with step **2611**. As shown in FIG. **26**, during step **2614**, a warming agent **2314** is passed through channels **2304** of mold **2602** to loosen ice cubes **2660** from mold **2602**. During step **2614**, cooling agent **2302** may continue to be passed through channels **2304** of mold **2604** in order to being to cool mold **2604**. Freezing of water in mold **2604** may begin in step **2614**.

[0136] Step **2615** is the mirror image of step **2612**. During step **2615**, passing cooling agent **2302** through channels **2304** continues, thus continuing the cooling of mold **2604**, and the freezing of the water in mold **2604**. During step **2615**, extractor bar **2658** is moved away from mold **2602**, thereby moving water filling needles **2620** associated with extractor bar **2568** and ice cubes **2660** away from mold **2602**. Moving of ice cubes **2660** away from mold **2602** may be facilitated by continuing to heat mold **2602**, thereby heating the ice-mold interface.

[0137] In step **2616**, heating of mold **2604** may begin to heat the ice-mold interface. In step **2616**, extractor bar **2658** may be moved towards ice cube remover **2652**. Ice cube remover **2652** may be a rod or bar. When ice cubes **2660** come into contact with ice cube remover **2652**, ice cube remover **2652** knocks or pushes ice cubes **2660** off of water filling needles **2620**. During step **2616**, cooling agent **2302** may begin to be passed through channels **2304** of mold **2602** in order to begin to cool mold **2602**.

[0138] Each mold **2602** and **2604** may have an 80 second ice cube production cycle in accordance with procedure **2600**.

[0139] FIGS. **27**A, **27**B, and **27**C illustrate a water filling system **2700** in accordance with at least one aspect of the disclosure. FIG. **27**A is a side view, FIG. **27**B is a bottom view, and FIG. **27**C is a front view of water filling system **2700**. Water filling system **2700** comprises water supply needles **2702**, water inlets **2704**, and chamber **2706**. Water enters through water inlets **2704** and empties into chamber **2706**. Water exits chamber **2706** through water supply needles **2702**. Needles **2702** may be the same as needles **2620** and **2630** previously described.

[0140] FIGS. **28**A, **28**B, **28**C, and **28**D illustrate an ice harvesting apparatus **2800**. Ice harvesting apparatus may comprise water filling system **2700**, and water filling needles **2702**. As shown in FIG. **28**A, water may be filled into mold **2802**, and frozen using a cooling agent (not shown). After the water has been frozen, the water filling system **2700**, including water filling needles **2702** may be moved away from mold **2802** as shown in FIG. **28**B, thereby removing ice cubes **2830** that are attached to needles **2702**. The water filling system **2700** may be retained on an arm **2804**. Arm **2804** may be supported by support **2820**. Arm **2804** may be pivoted or tilted up and away from mold **2802** as shown in FIG. **28**B, taking with arm **2804** the water filling system **2700** and ice cubes attached to needles **2702**. Motor **2816** may provide power to tilt arm **2804**. Those of skill in the art will recognize that in accordance with the disclosure, motor **2816** may be any suitable motor, including but not limited to a hydraulic motor. Arm **2804** may be pivoted on pivot **2818** on support **2820**.

[0141] Water filling system **2700** may be moved along arm **2804** towards ice cube remover **2806**, as shown in FIG. **28**C. When the ice cubes **2830** attached to needles **2702** come into contact with ice cube remover **2806**, the ice cubes are knocked or pushed off of needles **2702**, and drop into ice hopper **2808**, as shown in FIG. **28**C and FIG. **28**D. Water filling system **2700** may comprise an extractor bar, e.g., extractor bar **2656** or **2658**, previously described. Alternatively, extractor bar **2656** or **2658** may comprise a water filling system, e.g., water filling system **2700**. Ice cube remover **2806** may be the same as or similar to ice cube remover **2650** or **2652**, previously described.

[0142] Water filling system **2700** may be connected to extension arm **2810**. Extension arm **2810** may be configured to extend and retract from housing **2812**. Motor **2814** may be configured to provide power to move a distal end **2822** of extension arm **2810** away from housing **2812**, thereby moving water filling system **2700** towards ice cube remover **2806**. After ice cubes **2830** have been removed from needles **2720** by ice cube remover **2806**, motor **2814** may provide power to move distal end **2822** of extension arm **2810** back towards housing **2812**, thereby moving water filling system **2700** back to mold **2802**. After water filling system **2700** is moved along arm **2804** to mold **2802**, arm **2804** may then be pivoted or tiled down (powered by motor **2816**) so that arm **2804** is perpendicular to the floor **2824**, whereupon water filling system **2700** may fill mold **2802** with water and the ice cube making and ice cube harvesting procedure may be repeated. Those of skill in the art will recognize that in accordance with the disclosure, motor **2814** may be any suitable motor, including but not limited to a hydraulic motor.

[0143] FIGS. **29**A through **29**I further illustrates ice harvesting in accordance with the apparatus shown in FIGS. **28**A, **28**B, **28**C, and **28**D. FIGS. **29**A, **29**D, and **29**G are side views, FIGS. **29**B, **29**E, and **29**H are bottom perspective views, and FIGS. **29**C, **29**F, and **29**I are front views of water filling system **2700**, arm **2804**, and ice cube remover **2806**. For illustration purposes, two rows of ice cubes **2830** are shown in these figures for a total of ten (10) ice cubes **2830**, although water filling system has 45 water filling needles in an array of 9×5. Ice cube remover **2806** may comprise channels **2912**. Channels **2912** may be configured to allow needles **2702** to enter and move through channels **2912**. Ice cube remover **2806** may be attached to arms **2902** and **2904**. Ice cube remover **2806** may have posts **2914** that extend down from loops **2908** of arms **2902** and **2904**. Ice cube remover **2806** may have a grid **2916** that slants down at an angle from posts **2914**. Grid **2916** may define channels **2912**.

[0144] As shown in FIGS. **29**A through **29**I, water filling system **2700** also comprises an extractor bar **2656**, and needles **2702**. In the embodiment shown, arm **2804** comprises a first arm **2902** and a second arm **2904**. Each arm **2902** and **2904** may define a pivot hole **2906** and an elongated loop **2908**. Pivot holes **2906** may be configured to receive pivots **2818**. Wheels **2910** may be configured to rotate and move along the elongated loop **2908** of each arm **2902** and **2904**. Wheels **2910** may rotate when water filling system **2700** is moved along arm **2804**, i.e., each arm **2902** and arm **2904**.

[0145] As shown in FIGS. **29**A through **29**I, ice cubes **2830** may be moved in relation to ice cube remover **2806** until they are knocked or pushed off of needles **2702** by ice cube remover **2806**.

[0146] The apparatus shown and described above in connection with FIGS. **27**A through **27**C, FIGS. **28**A through **28**D, and FIGS. **29**A through **29**I may be used in a 30 second harvesting operation.

[0147] The following is a description of an apparatus that may be used in a harvesting operation that may be less than 30 seconds. More specifically, the apparatus described below in connection with FIGS. **30** through **32**L may be used in a harvesting operation that is about 17 seconds.

[0148] FIG. **30** illustrates a side view of a water filling system **3000**. Water filling system **3000** may comprise a water filling vessel **3002**, a cooled cover **3004**, and insulated water channels **3006**. Also shown in FIG. **30** is ice cube mold **3008**. Ice cube mold **3008** may be the same as or similar to mold **1602** or **2802**, previously described. Water may flow from water filling vessel **3002**, through the insulated water channels **3006**, which are cooled by cooled cover **3004**, thus cooling the water. The water may flow from insulated water channels **3006** through water filling nozzles **3014** and into ice cube mold **3008**. A cooling agent **3010** may flow through cooling channels **3012**. Cooling channels **3012** may be perpendicular to insulated water channels **3006**. Water may be cooled further by ice cube mold **3008** until the water turns to ice in ice cube mold **3008**.

[0149] FIG. **31**A, **31**B, **31**C, and **31**D illustrate an ice harvesting apparatus **3100**. Ice harvesting apparatus **3100** may be similar to ice harvesting apparatus **2800**, previously described. Ice harvesting apparatus **3100** may comprise water filling system **3000**, an articulating cooling agent supply line **3102**, and an ice cube remover **3104**. In other respects ice harvesting apparatus **3100** may be similar to or the same as ice harvesting apparatus **2800**. As previously noted, mold **3008** may be the same as or similar to mold **1602** or **2802**, previously described. For illustration purposes, ice cubes **3106** are shown only in FIG. **31**A and FIG. **31**D.

[0150] As shown in FIG. **30**, water may be filled into mold **3008**, and frozen in mold **3008**. After the water has been frozen in mold **3008**, the ice-mold interface may be loosened by heat applied to mold **3008** in accordance with warming or heating of molds previously discussed herein, or the ice-mold interface may be loose due to a low adhesion coating on mold **3008**. Once the ice-mold interface is sufficiently loose, the water filling system **3000**, including water filling nozzles **3014** may be moved away from mold **3008** as shown in FIG. **31**A, thereby removing ice cubes **3106** that are attached to water filling nozzles **3014**. The water filling system **3000** may be retained on an arm **2804**. Arm **2804** may be supported by support **2820**. Arm **2804** may be pivoted or tilted up and away from mold **3008** as shown in FIG. **31**A, taking with arm **2804** the water filling system **3000** and ice cubes **3106** attached to water filling nozzles **3014**. Motor **2816** may provide power to tilt arm **2804**. Those of skill in the art will recognize that in accordance with the disclosure, motor **2816** may be any suitable motor, including but not limited to a hydraulic motor. Arm **2804** may be pivoted on pivot **2818** on support **2820**.

[0151] Water filling system **3000** may be moved along arm **2804** towards ice cube remover **3104**, as shown in FIG. **31**B. When the ice cubes **3106** attached to nozzles **3014** come into contact with ice cube remover **3104**, the ice cubes **3106** are knocked or pushed off of nozzles **3014**, and drop into an ice hopper, such as ice hopper **2808**, as shown in FIG. **28**C and FIG. **28**D. Water filling system **3000** may comprise an extractor bar, e.g., extractor bar **2656** or **2658**, previously described. Alternatively, extractor bar **2656** or **2658** may comprise a water filling system, e.g., water filling system **3000**. Ice cube remover **3104** may be the same as or similar to ice cube remover **2650** or **2652**, previously described.

[0152] Water filling system **3000** may be connected to extension arm **2810**. Extension arm **2810** may be configured to extend and retract from housing **2812**. Motor **2814** may be configured to provide power to move a distal end **2822** of extension arm **2810** away from housing **2812**, thereby moving water filling system **3000** towards ice cube remover **3104**. After ice cubes **3106** have been removed from nozzles **3014** by ice cube remover **3104**, motor **2814** may provide power to move distal end **2822** of extension arm **2810** back towards housing **2812**, thereby moving water filling system **3000** back to mold **3008**. After water filling system **3000** is moved along arm **2804** to mold **3008**, arm **2804** may then be pivoted or tiled down (powered by motor **2816**) so that arm **2804** is perpendicular to the floor **2824**, whereupon water filling system **3000** may fill mold **3008** with water and the ice cube making and ice cube harvesting procedure may be repeated. Those of skill in the art will recognize that in accordance with the disclosure, motor **2814** may be any suitable motor, including but not limited to a hydraulic motor.

[0153] FIGS. **32**A through **32**L further illustrates ice harvesting in accordance with the apparatus shown in FIGS. **31**A, **31**B, **31**C, and **31**D. FIGS. **32**A, **32**D, **32**G, and **32**J are side views, FIGS. **32**B, **32**E, **32**H, and **32** K are bottom perspective views, and FIGS. **32**C, **32**F, **321**, and **32**L are front views of water filling system **3000**, arm **2804**, and ice cube remover **3104**. As shown in this embodiment, five rows of ice cubes **3106**, with nine ice cubes in each row provide a total of forty-five (45) ice cubes (9×5 array) for harvesting. Ice cube remover **3104** may comprise ice cube removing bars **3200**. Ice cube remover **3104** may be attached to arms **2902** and **2904**. Ice cube remover **3104** may have brackets **3202** that may be configured to pivot about pivots **3204**, thereby raising or lowering ice cube removing bars **3200** as desired.

[0154] FIGS. **32**A through **32**C show the position of ice cubes **3106** in relation to brackets **3202** before ice cubes **3106** are moved along arms **2902** and **2904** towards brackets **3203**. FIGS. **32**D through **32**F show the position of ice cubes after ice cubes have moved along arms **2902** and **2904** so that they hover over ice cube removing bars **3200**. FIGS. **32**G through **32**H show the position of ice cube removing bars **3200** after they have been pivoted into the spaces between the ice cubes **3106**. FIGS. **32**J through **32**K show that as ice cube removing bars **3200** are pivoted further about pivots **3204**, bars **3200** knock or push ice cubes **3106** off of nozzles **3014**. At the same time, or in an alternative embodiment, after bars **3200** have been pivoted into the spaces between the ice cubes **3106**, the water filling system **3000** may be moved further along arm **2804** until they are knocked or pushed off of nozzles **3014** by bars **3200**.

[0155] In an aspect of the disclosure an ice making apparatus is provided. The ice making apparatus may comprise a mold, the mold defining a first volume for an ice cube, the mold comprising a bottom face having an inner perimeter and side faces. Each side face of the mold may have a corresponding inner perimeter, a corresponding top edge, and a corresponding bottom edge. The corresponding top edge of each side face may be longer than the corresponding bottom edge. Each side face may extend inward from the corresponding top edge to the corresponding bottom edge. The mold may comprise a three-dimensional shape, the three-dimensional shape located within the first volume, the three-dimensional shape comprising a second volume. The second volume may be defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge of the three-dimensional shape. The bulge may extend upwardly between the bottom outer perimeter and the top outer perimeter. The bulge may taper as it extends upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape. The mold may further define a third volume between the first volume and the second volume, with the mold configured to receive water within the third volume. The apparatus may comprise a cooling device configured to cool water within the third volume sufficiently to freeze the water. Those of skill in the art will recognize that in accordance with the disclosure, any suitable cooling device may be used to freeze water in the mold. For example, the cooling device may comprise one or more passageways configured to receive a cooling agent having a sufficiently low temperature that when the cooling agent flows through the one or more passageways, heat transfer will occur between the water in the mold and the mold such that the water in the mold will freeze. A suitable cooling device may comprise an evaporator.

[0156] In an aspect, the bottom face and the side faces of the mold comprise parallelograms. In an aspect, the ice making apparatus may comprise an evaporator, the evaporator configured to provide a cooling agent to the cooling device, the cooling agent having a temperature sufficient to freeze the water in the third volume. In an aspect, the mold may comprise a mold body. The mold body may comprise a plurality of molds cells. In an aspect, each mold cell may comprise a fin. Each fin may be connected to the mold body. In an aspect, the mold may comprise a plurality of passageways. Each passageway may be configured to receive a cooling agent and provide sufficient heat transfer from water within the mold cells to the mold cells, and freezing the water within the mold cells.

[0157] In an aspect, the three-dimensional shape may comprise a substantially three-dimensional U-shape. In an aspect, the three-dimensional shape may comprise a substantially three-dimensional truncated M-shape. In an aspect, the three-dimensional shape may comprise a set of at least two three-dimensional L-shapes. In an aspect, the at least two three-dimensional L shapes may be mirror images of each other. In an aspect, the three-dimensional shape may further comprise a third three-dimensional shape. The third three-dimensional shape may be positioned between and joining the at least two three-dimensional L-shapes. In an aspect, the bulge may comprise at least two fins. In an aspect, the bulge may comprise four side faces. In an aspect, the four side faces may be parallelograms.

[0158] In an aspect of the disclosure an ice making apparatus is provided comprising an mold. The mold may comprise an upper part and a lower part. Each of the parts may comprise a plurality of ice cube mold cells corresponding to a plurality of ice cube mold cells of the other part. The mold may be configured so that a first mold cell of the lower part of the mold and a corresponding second cell of the upper part of the mold comprises a single enclosure. The single enclosure may define a volume for a single ice cube. A first channel may be configured to fill the first mold cell and the corresponding second mold cell with water. A second channel may be configured to allow air to escape from the single enclosure when the first mold cell and the second mold cell are filled with water. A plurality of passageways may be configured to receive a cooling agent and provide sufficient heat transfer from water within the mold cells to the mold cells, and freezing the water within the mold cells.

[0159] In an aspect, a seal coating may be provided at a surface area wherein the upper part meets the lower part.

[0160] In an aspect of the disclosure an ice making apparatus is provided comprising a mold and a plate. The mold may be positioned over the plate. The mold may comprise a plurality of ice cube mold cells, each ice cube mold cell may comprise an opening at the bottom of the cell, and an air escape channel at the top of the cell to allow air to escape from the ice cube mold cell when the plate is filled with water. The mold and the plate may each comprise a plurality of passageways, each passageway configured to receive a cooling agent and provide sufficient heat transfer from water within the ice cube mold cells to the ice cube mold cells, and freeze water within the ice cube mold cells. Each ice cube mold cell may comprise a corresponding channel to allow air escape from the ice cube mold cell when the plate is filled with water.

[0161] In an aspect, the ice cube mold cells may have a shape of a truncated pyramid.

[0162] In an aspect of the disclosure a method of making a plurality of ice cubes is provided. The method may comprise placing a mold over a plate. The mold may comprise a plurality of cells, each cell having an opening at the bottom of the cell, and an air escape channel at the top of the cell. The method may comprise filling each of the plurality of cells by filling the plate with water, and transferring heat from water within the plurality of cells to the mold cells and freezing water within the cells.

[0163] In an aspect, in the above method, at least one ice cube may comprise the shape of a truncated pyramid.

[0164] In an aspect, each of the plurality of ice cubes may comprise a wall having a thickness sufficient to provide mechanical strength of an ice cube and an interior volume that is not completely frozen.

[0165] In an aspect, the thickness of the wall of each of the plurality of ice cubes may be in the range of about 2-3 mm.

[0166] In an aspect of the disclosure an ice making apparatus is provided comprising a mold, wherein the mold may comprise a plurality of cells. Each cell may have an opening at a top of each cell. The mold may comprise a plurality of passageways for a cooling agent, and an upper part. The upper part may be hermetically enclosed with a cover. The upper part may comprise a vacuum chamber. A vacuum pump may be provided, the vacuum pump configured to pump wet air from the mold. A pipe may be provided, the pipe extending from the vacuum chamber of the mold to the vacuum pump. When pressure in the vacuum chamber starts to decrease, dissolved gases start to leave the bulk of water in each cell. The vacuum pump may be configured to pump wet air from the mold so that the pressure in the vacuum chamber drops below 61 0.5 Pa ((0.18 in Hg) at 32° F.).

[0167] In an aspect of the disclosure an ice cube is provided. The ice cube may comprise a top face having an outer perimeter, a bottom face having an outer perimeter, and side faces. Each side face may include a corresponding outer perimeter, a corresponding top edge, and a corresponding bottom edge, the corresponding top edge of each side face being longer than the corresponding bottom edge, each side face extending inward from the corresponding top edge to the corresponding bottom edge. The top face, bottom face and side faces may define a first volume. In an embodiment, a three-dimensional shape may be provided, the three-dimensional shape located within the first volume. The three-dimensional shape may comprise a second volume. The second volume may be defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge. The bulge may extend upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape. The bulge may taper as it extends upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape. The ice cube may further define a third volume between the first volume and the second volume, the third volume comprising ice, and second volume comprising unfrozen liquid or air, or a combination of unfrozen liquid and air.

[0168] In an aspect of the disclosure, an increase in ice production rate can be achieved. The increase in ice production rate may be achieved by increasing ice cube surface area. For example, by increasing ice cube surface area, about 40-50 second freezing times and about 90 second entire ice production cycle may be achieved relative to 10-15 minute ice production cycles of convention method and apparatus.

[0169] A 90 second ice production cycle can translate into about 1.4 lbs./minute of an ice-on-demand production rate well within a footprint area, e.g., about 22 feet by 30 feet, and power limitations (e.g., less than about 5.5 kW), if a mold is expanded from a typical 45 cubes per mold to 50 cubes per mold.

[0170] The mold may be configured to provide mechanical robustness and hermetic properties under conditions when temperature changes may occur of many degrees Fahrenheit (e.g., hundreds of degrees Fahrenheit) in a few seconds and on a spacious scale of millimeters, i.e., extremely high temperature gradients.

[0171] In an aspect, harvesting of ice may be provided wherein positioning of each ice cube is controllable. In an aspect, an ice harvesting apparatus may provide improved ice delivery wherein each ice cube or a predetermined of ice cubes may be individually delivered to a predetermined location. In an aspect an ice harvesting apparatus may be provided that reduces or avoids the need for ice hopper agitation.

[0172] In an aspect, a de-aeration apparatus and method may be provided that allows for the making and harvesting of transparent or relatively transparent ice cubes.

[0173] In an aspect, an apparatus is provided comprising a distribution device, the distribution device comprising an inlet, an outlet, a pan, and a distribution body. The inlet may be configured to receive a cooling agent having a predetermined first temperature. The distribution body may be configured to receive the cooling agent from the inlet. The distribution body may be configured to distribute the cooling agent into the pan at predetermined locations of the pan and provide substantially equal cooling to a plurality of molds in heat transfer communication with the cooling agent as the cooling agent flows through the pan to the outlet. The outlet may be configured to receive the cooling agent from the pan, wherein the cooling agent has second temperature upon exit of the pan through the outlet, the second temperature of the cooling agent at the outlet being different than the first temperature of the cooling agent at the inlet.

[0174] In an aspect, the first temperature of the cooling agent at the inlet is lower than the second temperature of the cooling agent at the outlet. In an aspect, the first temperature of the cooling agent at the inlet is sufficient to freeze water in a plurality of molds in contact with the cooling agent. In an aspect, the distribution body has a length, width, and height that is each less than a corresponding length, width, and height of the pan. The distribution body may define holes to distribute the cooling agent into the pan at predetermined locations of the pan.

[0175] In an aspect, the distribution body may comprise a first end, a second end, a first side surface, and a second side surface. The second side surface may be opposite the first side surface, and a bottom surface, wherein the bottom surface is opposite the top surface, wherein the first end is in fluid communication with the inlet, wherein the second end is closer to the outlet than the first end. The distribution body may comprise a first section, a second section, and a third section, wherein the first section is between the inlet and the second section, wherein the second section is between the first section and the third section, and wherein the third section comprises the second end. The first section may defines a first set of holes, the first set of holes comprising at least one hole located at the first side surface and at least one hold located at the second side surface. The second section may define a second set of holes, the second set of holes comprising at least one hole located at the first side surface and at least one hole located at the second side surface. The third section may define a third set of holes, the third set of holes comprising at least one hole located on at the first side surface and at least one hole located on the second side surface.

[0176] The first set of holes comprises two holes at the first side surface and two holes at the second side surface opposite the two holes at the first side surface. The second set of holes may comprise a hole at the first side surface and a hole at the second side surface opposite the hole at the first side surface. The second set of holes may comprise a hole at the top surface of the distribution body. The third set of holes may comprise three holes at the first side surface and three holes at the second side surface opposite the three holes at the first side surface. The third set of holes may comprise two holes at the top surface of the distribution body.

[0177] In an aspect, the pan may comprise an end in fluid communication with an outlet. The end of the pan may comprise a plurality of holes in fluid communication with the outlet. The end of the pan may comprise a funnel in fluid communication with the outlet.

[0178] In an aspect, the apparatus may comprise a mold, the mold comprising a plurality of ice cube molds, the mold configured to lie over a bottom surface of the pan and be positioned in heat transfer communication with the cooling agent between the distribution body and an end of the pan.

[0179] In an aspect, the inlet may be configured to receive a warming agent, the warming agent having a predetermined inlet temperature, wherein when the warming agent flows through the pan, the warming agent warms an ice-mold interface between ice cubes previously formed in the plurality of molds. The warming agent may have an outlet temperature at the outlet, the inlet temperature of the warming agent being higher than the outlet temperature of the warming agent.

[0180] In an aspect, an apparatus may be provided comprising a distribution device, the distribution device comprising an inlet, an outlet, a pan, and a distribution body. The inlet may be configured to receive a warming agent having a predetermined inlet temperature. The distribution body may be configured to receive the warming agent from the inlet, the distribution body configured to distribute the warming agent into the pan at predetermined locations of the pan and provide substantially equal warming to a plurality of molds in heat transfer communication with the warming agent as the warming agent flows through the pan to the outlet. The outlet may be configured to receive the warming agent from the pan, wherein the warming agent has an outlet temperature upon exit of the pan through the outlet, the outlet temperature of the warming agent at the outlet being different than the inlet temperature of the warming agent at the inlet.

[0181] In an aspect, the inlet temperature of the warming agent at the inlet is higher than the outlet temperature of the warming agent at the outlet. In an aspect, the inlet temperature of the warming agent at the inlet is sufficient to warm an ice-mold interface between ice and the plurality of molds.

[0182] In an aspect, a device is provided comprising a first ice cube mold, the first ice cube mold comprising a top face and a bottom face, the top face of the first ice cube mold comprising a first plurality of mold cells. The device may comprise a second ice cube mold, the second ice cube mold comprising a top face and bottom face, the top face of the second ice cube mold comprising a second plurality of mold cells (**1608**). The device may comprise a housing, the housing having an axis that is parallel to the bottom face of the first ice cube mold and parallel to the bottom face of the second ice cube mold. The first ice cube mold may be positioned in the housing with the top face of the first ice cube mold facing up. The second ice cube mold may be positioned in the housing with the top face of the second ice cube mold facing down, wherein the bottom face of the first ice cube mold is in a back-to-back orientation with the bottom face of the second ice cube mold. The housing may be configured to rotate about the axis and rotate the first ice cube mold so that the top face of the first ice cube mold faces down, and the rotate the second ice cube mold so that the top face of the second ice cube mold faces up.

[0183] The device may comprise a shaft. The shaft may be configured to rotate the housing about the axis. The device may comprise a first subassembly. The first subassembly may comprise the first ice cube mold, a first top cover, and a first bottom cover, the first ice cube mold retained between the first top cover and the first bottom cover. The device may comprise a second subassembly. The second subassembly may comprise the second ice cube mold, a second top cover, and a second bottom cover, the second ice cube mold retained between the second top cover and the second bottom cover.

[0184] The device may comprise a first heat transfer device, the first heat transfer device positioned between first ice cube mold and the first bottom cover; and a second heat transfer device, the second heat transfer device positioned between second ice cube mold and the second bottom cover. The first heat transfer device may comprise a first set of cooling fins, and the second heat transfer device may comprise a second set of cooling fins. The first top cover may define a first top cover opening. The first top cover opening may be configured so that when the first top cover is placed over the first ice cube mold, the first top cover opening allows for the plurality of mold cells of the first ice cube mold to be filled with a liquid when the first ice cube mold is in an upwardly facing position. The first top cover opening may be configured so that the first top cover opening allows for a plurality of ice cubes formed in the mold cells of the first ice cube mold to drop from the mold cells of the first ice cube mold when the first ice cube mold is in a downwardly facing position.

[0185] The device may comprise a cooling agent tube configured to supply a cooling agent in heat transfer communication with the first ice cube mold and freeze liquid in the mold cells of the first ice cube mold when the first ice cube mold is in the upwardly facing position. The device may comprise a warming agent tube configured to supply a warming agent in heat transfer communication with the first ice cube mold and heat an ice-mold interface between ice and the mold cells of the first ice cube mold when the first ice cube mold is in the downwardly facing position.

[0186] In an aspect, a method is provided comprising freezing a liquid in a plurality of mold cells of an ice cube mold to form ice cubes, the ice cube mold facing up. The method may comprise rotating the ice cube mold so that the ice cube mold faces down. The method may comprise warming the ice cube mold to loosen an ice-mold interface between the ice cubes and the ice cube mold and allow the ice cubes to drop out of the ice cube mold. The method may comprise moving a harvest assist rod relative to the ice cube mold to facilitate removal of ice cubes from the ice cube mold. The freezing of the liquid may comprise method may comprise cooling the liquid with a cooling agent in heat transfer communication with the liquid. The method may comprise sending the cooling agent through a plurality of channels, wherein each channel corresponds one of the mold cells. The warming of the ice cube mold may comprise warming the ice cube mold with a warming agent in heat transfer communication with the ice cube mold. The method may comprise sending the warming agent through a plurality of channels, wherein each channel corresponds one of the mold cells. The warming of the ice cube mold may comprise heating of the ice cube mold with a thin film electric heater, the thin film electric heater positioned around at least a portion of each mold cell. The warming of the ice cube mold may comprise heating of the ice cube mold with a light source and a light absorbing coating, the light absorbing coating positioned around at least a portion of each mold cell and which absorbs light emitted from the light source.

[0187] The freezing of the liquid may comprise cooling the liquid with a cooling agent in heat transfer communication with the liquid by sending the cooling agent through a plurality of channels, wherein there is a first set of channels below the mold cells, and a second set channels above the mold cells, and wherein there is a channel above and below each corresponding mold cell. The second set of channels may be positioned within a heat transfer plate. The method may comprise, after freezing of the liquid in the mold, warming of the heat transfer plate to loosen an ice-plate interface between the ice cubes in the mold and the plate. The warming of the heat transfer plate may comprise sending the warming agent through the second set of channels. The warming of the heat transfer plate may comprise heating of the heat transfer plate with a thin film electric heater.

[0188] In an aspect, a method is provide comprise freezing a liquid in a plurality of mold cells of an ice cube mold to form ice cubes, the ice cube mold facing up. The method may comprise rotating the ice cube mold so that the ice cube mold faces down. The method may comprise providing a low adhesion coating around at least a portion of the mold cells sufficient to allow the ice cubes to at least partially drop out of the ice cube mold after the step of rotating. The method may comprise moving a harvest assist rod relative to the ice cube mold to facilitate removal of the ice cubes from the ice cube mold. The method may comprise cooling the liquid with a cooling agent in heat transfer communication with the liquid by sending the cooling agent through a plurality of channels, wherein there is a first set of channels below the mold cells, and a second set channels above the mold cells, and wherein there is a channel above and below each corresponding mold cell.

[0189] In an aspect, a method is provided comprising placing liquid in a plurality of mold cells of an ice cube mold, placing an extractor in the liquid in each of the mold cells, and freezing the liquid in each of the mold cells to form ice cubes, the ice cube mold facing up. The method may comprise warming the ice cube mold to loosen an ice-mold interface between the ice cubes and the ice cube mold. The method may comprise moving each extractor away from the ice cube mold, thereby moving an ice cube corresponding to each extractor away from the ice cube mold. The method may comprise warming each extractor to loosen an ice-mold interface between each ice cube and the corresponding extractor to allow each ice cube to drop from the corresponding extractor.

[0190] The warming of the ice cube mold may comprise warming the ice cube mold with a warming agent in heat transfer communication with the ice cube mold. The method may comprise sending the warming agent through a plurality of channels, wherein each channel corresponds one of the mold cells. The warming of the ice cube mold may comprise heating of the ice cube mold with a thin film electric heater, the thin film electric heater positioned around at least a portion of each mold cell. The warming of the ice cube mold may comprise heating of the ice cube mold with a light source and a light absorbing coating, the light absorbing coating positioned around at least a portion of each mold cell and which absorbs light emitted from the light source.

[0191] In an aspect, a method is provided comprising placing liquid in a plurality of mold cells of an ice cube mold, placing an extractor in the liquid in each of the mold cells, freezing liquid in each of the mold cells to form ice cubes, the ice cube mold facing up, and providing a low adhesion coating around at least a portion of the mold cells sufficient to allow the ice cubes to be moved away from the ice cube mold when the extractors are moved away from the ice cube mold. The method may comprise moving each extractor away from the ice cube mold, thereby moving an ice cube corresponding to each extractor away from the ice cube mold. The method may comprise warming each extractor to loosen an ice-mold interface between each ice cube and the corresponding extractor to allow each ice cube to drop from the corresponding extractor.

[0192] In an aspect, a method is provided comprising freezing a liquid in a plurality of mold cells of an ice cube mold to form ice cubes, the ice cube mold facing up, the freezing of the liquid further comprising cooling the liquid with a cooling agent in heat transfer communication with the liquid by sending the cooling agent through a plurality of channels, wherein there is a first set of channels below the mold cells, and a second set channels above the mold cells, and wherein there is a channel above and below each corresponding mold cell, wherein the second set of channels are positioned within a heat transfer plate. The method may comprise providing a low adhesion coating on the heat transfer plate sufficient to allow the heat transfer plate to be removed from the ice cubes while leaving the ice cubes in the mold cells. The method may comprise providing a low adhesion coating on at least a portion of the mold cells sufficient to allow the ice cubes to move at least partially away from the ice cube mold when the ice cube mold is rotated and the ice cube mold faces down. The method may comprise rotating the ice cube mold so that the ice cube mold faces down and the first set of channels is above the mold cells.

[0193] The method may comprise warming of an ice-mold interface between the ice cubes and the ice cube mold sufficient to allow ice cubes to drop from the ice cube mold when the ice cube mold is rotated so that the ice cube mold faces down. The warming may comprise sending a warming agent through the first set of channels. The warming may comprise heating of the ice cube mold with a thin film electric heater, the thin film electric heater positioned around at least a portion of each mold cell.

[0194] In an aspect, an apparatus is provided, the apparatus comprising an arm. The apparatus may comprise an ice cube mold comprising a plurality of ice cube mold cells, the ice cube mold configured to cool a liquid in the ice cube mold cells sufficient that an ice cube formed in each ice cube mold cell. The apparatus may comprise a water filling system. The water filling system may be configured to move along the arm. The water filling system may comprise water filling dispensers, each water filling dispenser configured to dispense a liquid to be frozen into a corresponding ice cube mold cell. Each water filling dispenser may be configured to move an ice cube formed in the corresponding ice cube mold cell away from the corresponding ice cube mold cell when the water filling system moves away from the ice cube mold. The apparatus may comprise an ice cube remover. The ice cube remover may be configured to push ice cubes off the water filling dispensers when the water filling system is moved along the arm toward the ice cube remover.

[0195] The water filling dispensers may comprise water filling needles and/or needles. The water filling system may comprise a cooled cover. The cooled cover may be configured to surround a portion of each water filling needle and/or nozzle. The cooled cover may be configured to cool water prior to being dispensed into the ice cube mold cells.

[0196] The arm may be configured to tilt from a horizontal position to a tilted position away from the ice cube mold.

[0197] As will be recognized by those skilled in the art, the above described embodiments may be configured to be compatible with fountain system requirements, and can accommodate a wide variety of fountain offerings, including but not limited beverages known under any PepsiCo branded name, such as Pepsi-Cola®, and custom beverage offerings. The embodiments described herein offer speed of service at least and fast or faster than conventional systems. The embodiments described herein may be configured to be monitored, including monitored remotely, with respect to operation and supply levels. The embodiments described herein are economically viable and can be constructed with off-the-shelf components, which may be modified in accordance with the disclosures herein.

[0198] Those of skill in the art will recognize that in accordance with the disclosure any of the features and/or options in one embodiment or example can be combined with any of the features and/or options of another embodiment or example.

[0199] The disclosure herein has been described and illustrated with reference to the embodiments of the figures, but it should be understood that the features of the disclosure are susceptible to modification, alteration, changes or substitution without departing significantly from the spirit of the disclosure. For example, the dimensions, number, size and shape of the various components may be altered to fit specific applications. Accordingly, the specific embodiments illustrated and described herein are for illustrative purposes only and the disclosure is not limited except by the following claims and their equivalents.

We claim:

1. An ice making apparatus comprising:

a mold for an ice cube, the mold comprising:

a first volume defined by the mold;

a bottom face having an inner perimeter;

side faces, each side face having a corresponding inner perimeter, a corresponding top edge, and a corresponding bottom edge, the corresponding top edge of each side face being longer than the corresponding bottom edge, each side face extending inward from the corresponding top edge to the corresponding bottom edge; and

a three-dimensional shape, the three-dimensional shape located within the first volume, the three-dimensional shape comprising a second volume, the second volume defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge of the three-dimensional shape, the bulge extending upwardly between the bottom outer perimeter and the top outer perimeter, the bulge tapering as it extends upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape;

the mold further defining a third volume between the first volume and the second volume, the mold configured to receive water within the third volume; and

a cooling device configured to cool water within the third volume sufficiently to freeze the water.

2. The ice making apparatus of claim **1**, wherein the bottom face and the side faces of the mold comprise parallelograms.

3. The ice making apparatus of claim **1**, further comprising an evaporator, the evaporator configured to provide a cooling agent to the cooling device, the cooling agent having a temperature sufficient to freeze the water in the third volume.

4. The ice making apparatus of claim **1**, wherein the mold comprises a mold body, the mold body comprising a plurality of molds cells.

5. The ice making apparatus of claim **4**, wherein each mold cell comprises a fin, each fin connected to the mold body.

6. The ice making apparatus of claim **5**, wherein the mold comprises a plurality of passageways, each passageway configured to receive a cooling agent and provide sufficient heat transfer from water within the mold cells to the mold cells, and freezing the water within the mold cells.

7. The ice making apparatus of claim **1**, wherein the three-dimensional shape comprises a substantially a three-dimensional U-shape.

8. The ice making apparatus of claim **1**, wherein the three-dimensional shape comprises a substantially a three-dimensional truncated M-shape.

9. The ice making apparatus of claim **1**, wherein the three-dimensional shape comprises a set of at least two three-dimensional L-shapes.

10. The ice making apparatus of claim **9**, wherein the at least two three-dimensional L shapes are mirror images of each other.

11. The ice making apparatus of claim **10**, wherein the three-dimensional shape further comprises a third three-dimensional shape, the third three-dimensional shape being positioned between and joining the at least two three-dimensional L-shapes.

12. The ice making apparatus of claim **1**, wherein the bulge comprises at least two fins.

13. The ice making apparatus of claim **1**, wherein the bulge comprises four side faces.

14. The ice making apparatus of claim **13**, wherein the four side faces are parallelograms.

15. An ice making apparatus comprising:

an mold, the mold comprising an upper part and a lower part, each of the parts having a plurality of ice cube mold cells corresponding to a plurality of ice cube mold cells of the other part, the mold configured so that a first mold cell of the lower part of the mold and a corresponding second cell of the upper part of the mold comprises a single enclosure, the single enclosure defining a volume for a single ice cube,

a first channel configured to fill the first mold cell and the corresponding second mold cell with water,

a second channel configured to allow air to escape from the single enclosure when the first mold cell and the second mold cell are filled with water, and

a plurality of passageways, each passageway configured to receive a cooling agent and provide sufficient heat transfer from water within the mold cells to the mold cells, and freezing the water within the mold cells.

16. The ice making apparatus of claim **15**, further comprising a seal coating at a surface area wherein the upper part meets the lower part.

17. An ice making apparatus comprising:

a plate; and

a mold, the mold positioned over the plate, the mold comprising a plurality of ice cube mold cells, each ice cube mold cell having an opening at the bottom of the cell, and an air escape channel at the top of the cell to allow air to escape from the ice cube mold cell when the plate is filled with water;

the mold and the plate each comprising a plurality of passageways, each passageway configured to receive a cooling agent and provide sufficient heat transfer from water within the ice cube mold cells to the ice cube mold cells, and freeze water within the ice cube mold cells;

each ice cube mold cell comprising a corresponding channel to allow air escape from the ice cube mold cell when the plate is filled with water.

18. The ice making apparatus of claim **17**, wherein the ice cube mold cells have a shape of a truncated pyramid.

19. A method of making a plurality of ice cubes, the method comprising:

placing a mold over a plate, the mold comprising a plurality of cells, each cell having an opening at the bottom of the cell, and an air escape channel at the top of the cell,

filling each of the plurality of cells by filling the plate with water, and transferring heat from water within the plurality of cells to the mold cells and freezing water within the cells.

20. The method of making a plurality of ice cubes of claim **19**, wherein at least one ice cube comprises the shape of a truncated pyramid.

21. The method of making a plurality of ice cubes of claim **19**, wherein each of the plurality of ice cubes comprises a wall having a thickness sufficient to provide mechanical strength of an ice cube and an interior volume that is not completely frozen.

22. The method of claim **21**, wherein the thickness of the wall of each of the plurality of ice cubes is in the range of about 2-3 mm.

23. An ice making apparatus comprising:

a mold, the mold comprising plurality of cells, each cell having an opening at a top of each cell, the mold comprising a plurality of passageways for a cooling agent, and an upper part that is hermetically enclosed with a cover, the upper part comprising a vacuum chamber,

a vacuum pump configured to pump wet air from the mold, and

a pipe, the pipe extending from the vacuum chamber of the evaporator to the vacuum pump,

wherein as pressure in the vacuum chamber starts to decrease, dissolved gases start to leave the bulk of water in each cell, the vacuum pump configured to pump wet air from the evaporator so that the pressure in the vacuum chamber drops below 61 0.5 Pa ((0.18 in Hg) at 32° F.).

24. A mold for an ice cube, the mold comprising:

a first volume defined by the mold;

a bottom face having an inner perimeter;

side faces, each side face having a corresponding inner perimeter, a corresponding top edge, and a corresponding bottom edge, the corresponding top edge of each side face being longer than the corresponding bottom edge, each side face extending inward from the corresponding top edge to the corresponding bottom edge; and

a three-dimensional shape, the three-dimensional shape located within the first volume, the three-dimensional shape comprising a second volume, the second volume defined by a top outer perimeter, a bottom outer perimeter, and at least a bulge of the three-dimensional shape, the bulge extending upwardly between the bottom outer perimeter and the top outer perimeter, the bulge tapering as it extends upwardly between the bottom outer perimeter and the top outer perimeter of the three-dimensional shape;

the mold further defining a third volume between the first volume and the second volume, the mold configured to receive water within the third volume.

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