US 20080104991A1

(19) **United States**

(12) **Patent Application Publication**

Hoehne et al.

(10) **Pub. No.: US 2008/0104991 A1**

(43) **Pub. Date: May 8, 2008**

(54) **ICE CUBE TRAY EVAPORATOR**

(76) Inventors: **Mark R. Hoehne**, Lake Villa, IL (US); **Mark W. Johnson**, South Milwaukee, WI (US)

Correspondence Address:
MICHAEL BEST & FRIEDRICH LLP
100 E WISCONSIN AVENUE, Suite 3300
MILWAUKEE, WI 53202

(21) Appl. No.: **11/592,421**

(22) Filed: **Nov. 3, 2006**

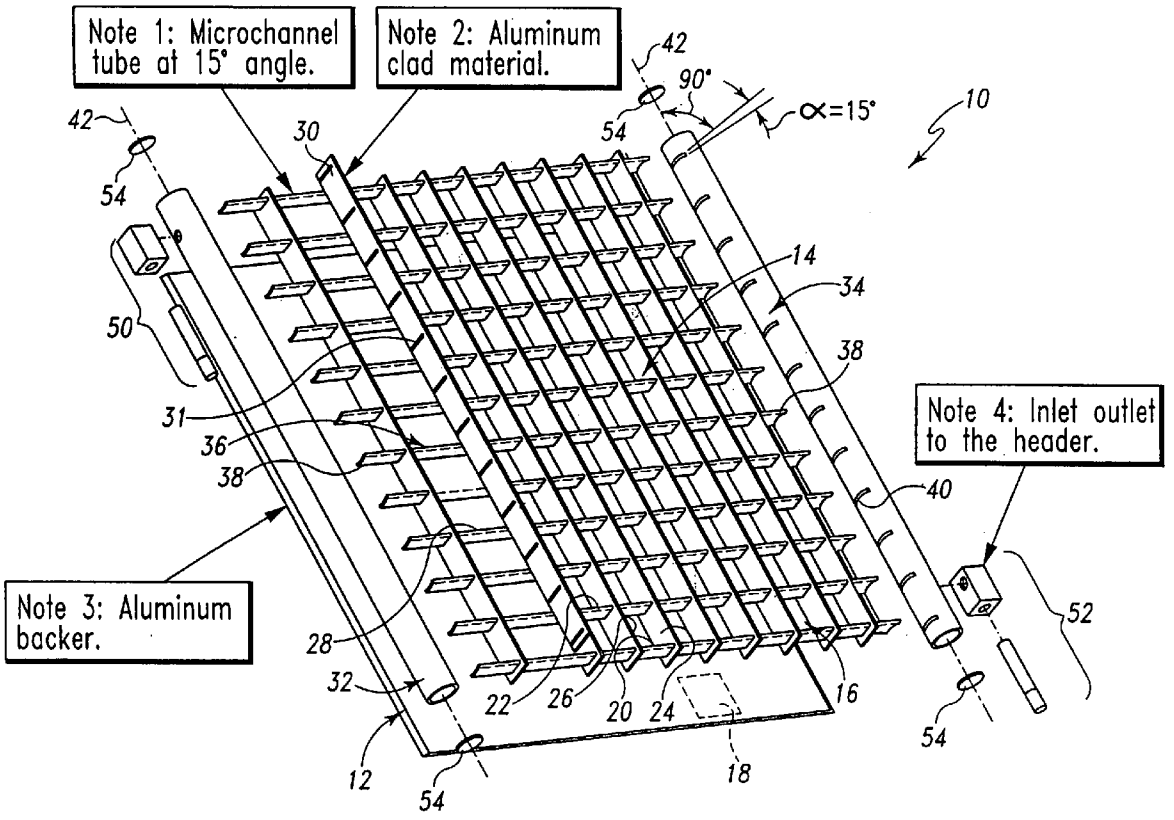
Publication Classification

(51) **Int. Cl.**
F25C 1/22 (2006.01)
B21D 51/18 (2006.01)

(52) **U.S. Cl.** **62/340**; 29/890.07

(57) **ABSTRACT**

An ice cube tray evaporator (**10**) includes a back plate (**12**) and a grid (**14**) of rectangular-shaped ice cube forming compartments (**16**) on the back plate (**12**). Each of the compartments (**16**) is defined by a back wall (**18**), and four side walls (**20**,**22**,**24**,**26**), with two of the side walls (**20**,**22**) being defined by parallel microchannel tube legs (**28**) spaced opposite from each other and the other two of the side walls (**24**,**26**) being defined by heat conductive strips (**30**).



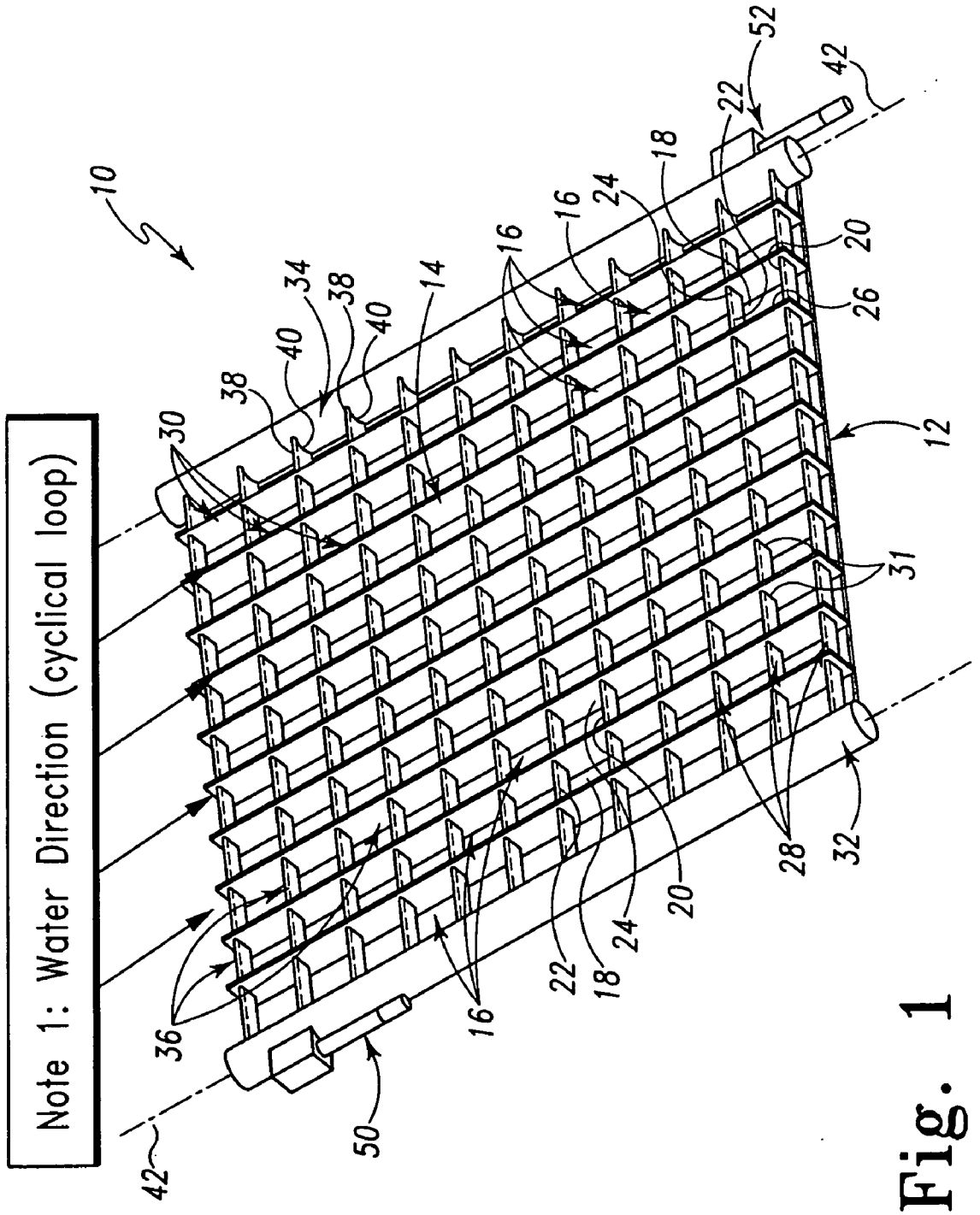

Note 1: Water Direction (cyclical loop)
10
12
14
16
18
20
22
24
26
28
30
31
32
34
36
38
40
42
50
52

Fig. 1

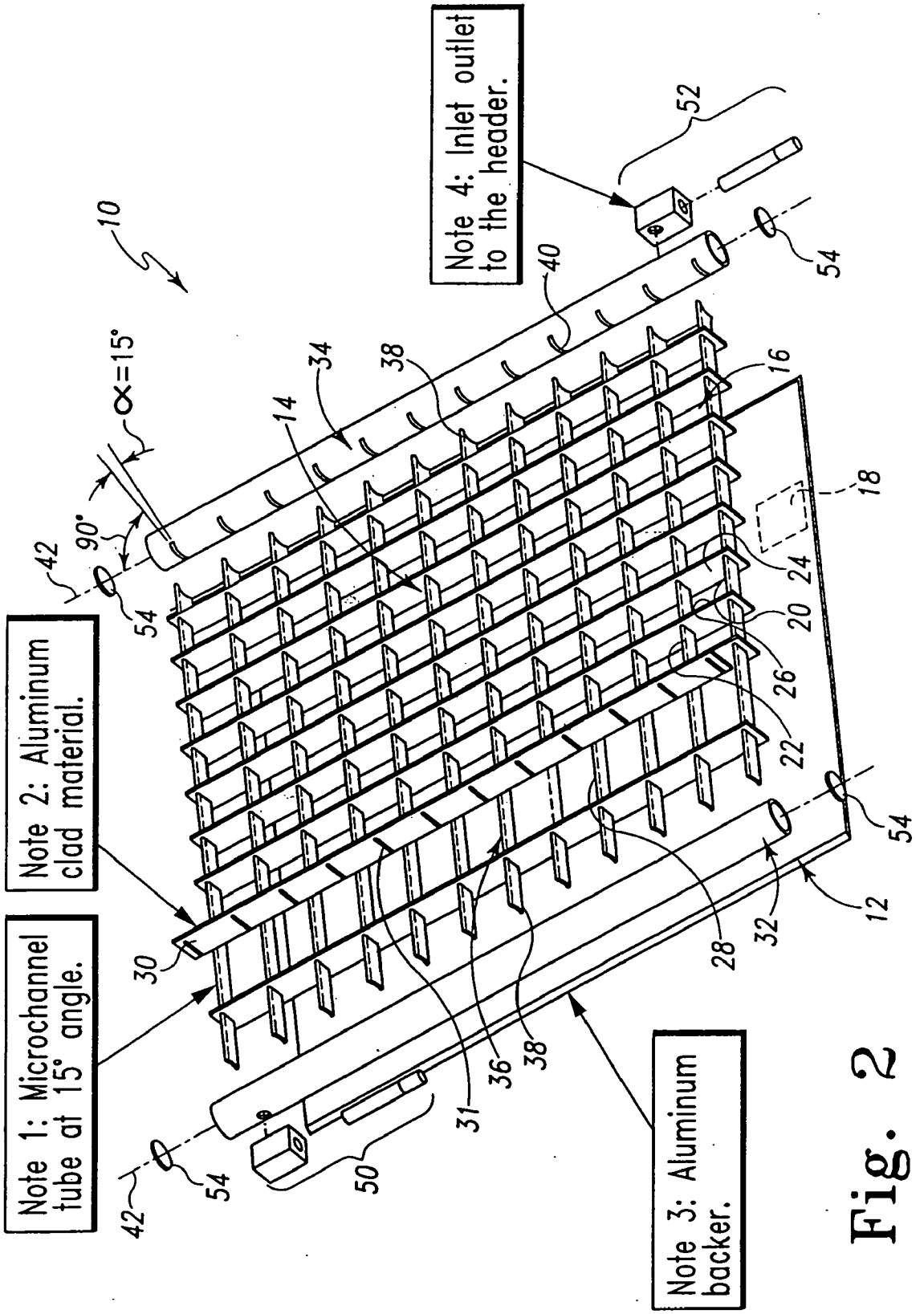

Note 1: Microchannel tube at 15° angle.
Note 2: Aluminum clad material.
Note 3: Aluminum backer.
Note 4: Inlet outlet to the header.
10
α=15°
90°
12
14
16
18
20
22
24
26
28
30
31
32
34
36
38
40
42
50
52
54

Fig. 2

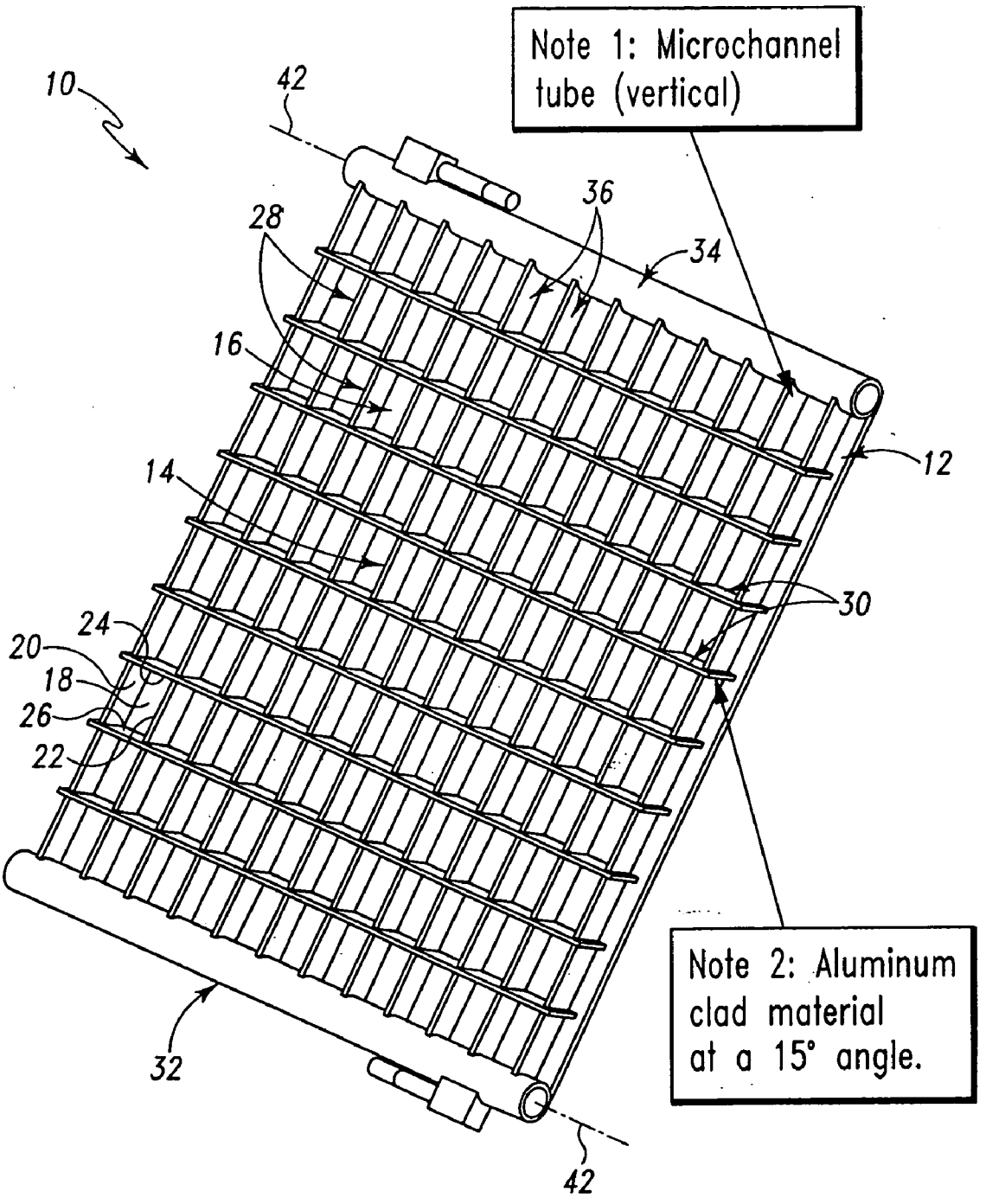

Note 1: Microchannel tube (vertical)
10
42
36
28
34
16
12
14
30
24
20
18
26
22
32
42
Note 2: Aluminum clad material at a 15° angle.

Fig. 3

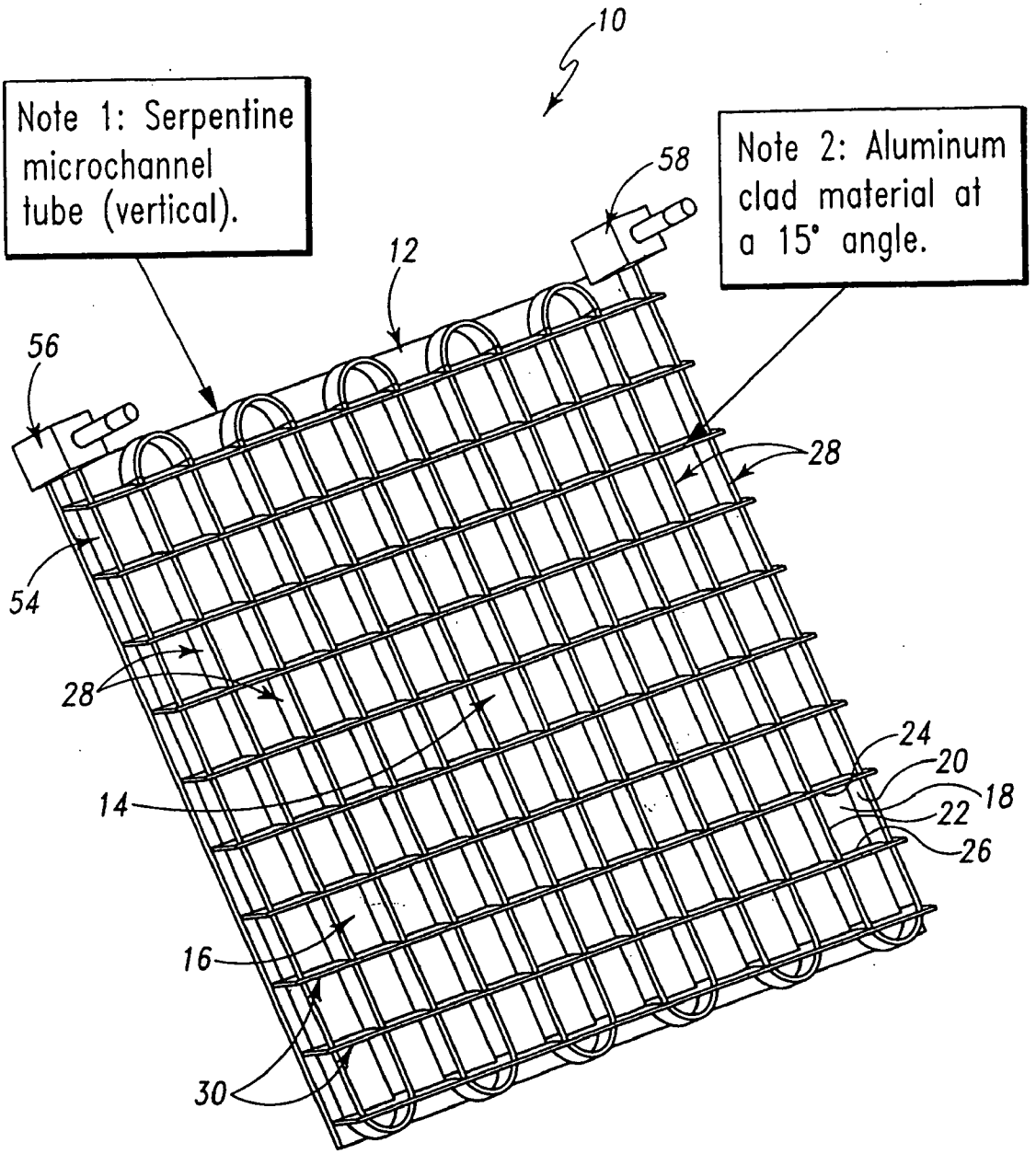

Note 1: Serpentine microchannel tube (vertical).
Note 2: Aluminum clad material at a 15° angle.
10
12
14
16
18
20
22
24
26
28
30
54
56
58

Fig. 4

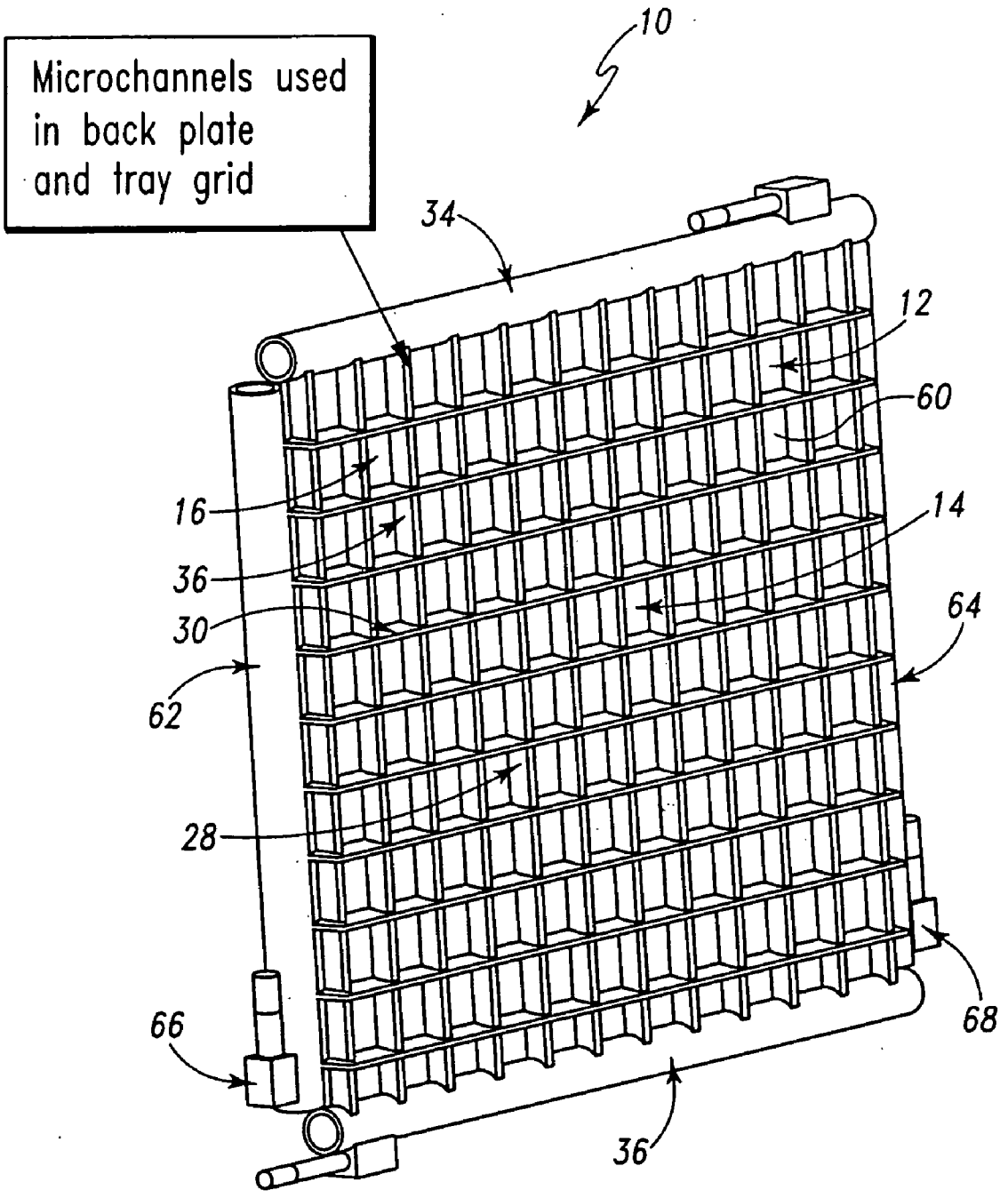

Microchannels used in back plate and tray grid
10
34
12
60
16
14
36
64
30
62
28
66
68
36

Fig. 5

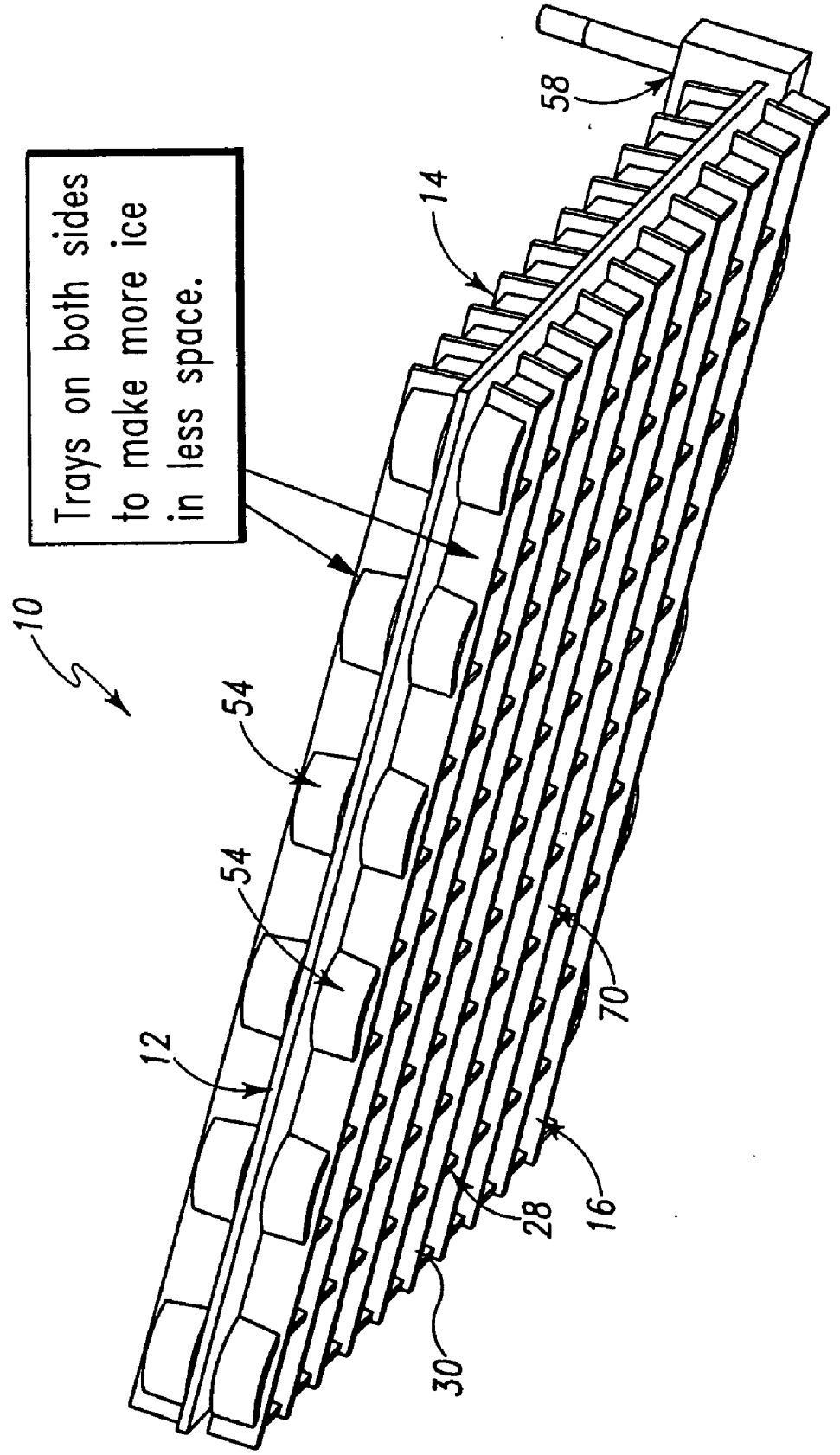

Trays on both sides to make more ice in less space.
10
12
14
16
28
30
54
54
58
70

Fig. 6

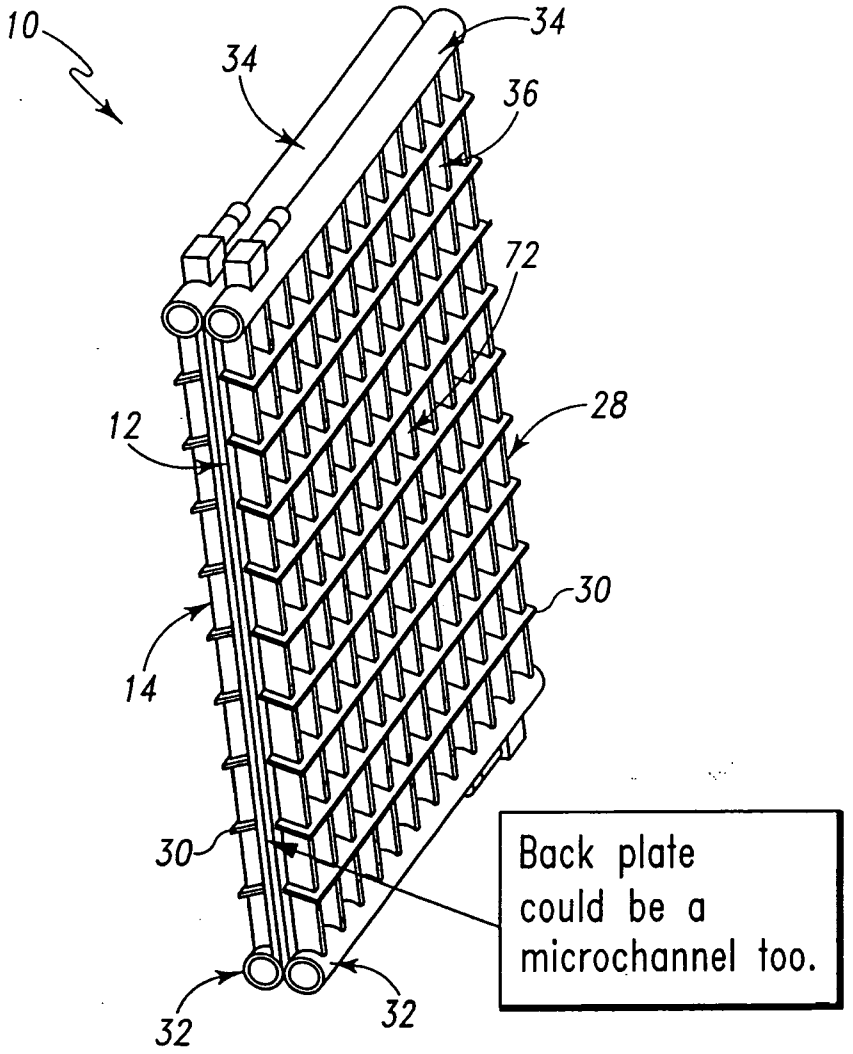

10
34
34
36
72
28
12
30
14
30
Back plate could be a microchannel too.
32
32

Fig. 7

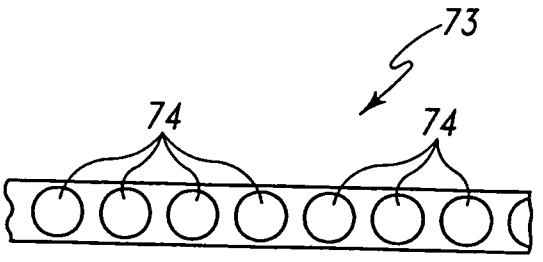

73
74
74

Fig. 8

ICE CUBE TRAY EVAPORATOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

MICROFICHE/COPYRIGHT REFERENCE

[0003] Not Applicable.

FIELD OF THE INVENTION

[0004] This invention relates to evaporators that are utilized in making ice cubes.

BACKGROUND OF THE INVENTION

[0005] Ice machines for ice cube producing are known to utilize ice cube forming trays wherein a grid of ice cube forming compartments is cooled by a back plate having an evaporator coil either attached to the back plate or formed as an integral part of the back plate. In some typical applications, a copper tube evaporator is brazed to a copper back plate and then the entire tray is nickel-plated. The tray is installed in a vertical orientation so that water flows down the front in a waterfall effect with the water freezing in the compartments as it flows through them. A defrost cycle releases the frozen ice cubes from the compartments, which may have a slight angle, such as 15° from perpendicular to vertical, so that the ice cubes slide out of the compartments under the force of gravity. While such constructions may be suitable for their intended purpose, there is always room for improvement.

SUMMARY OF THE INVENTION

[0006] In accordance with one feature of the invention, an ice cube tray evaporator includes a grid of ice cube forming compartments, with each compartment defined by a back wall and four side walls, and two of the side walls defined by microchannel tube legs spaced opposite from each other.

[0007] As one feature, the back wall of each compartment is defined by a microchannel tube.

[0008] In accordance with one feature of the invention, an ice cube tray evaporator includes a back plate; and a grid of ice cube forming compartments on the back plate. Each compartment is defined by the back plate and four side walls, with two of the side walls being defined by microchannel tube legs spaced opposite from each other.

[0009] In one feature, the ice cube tray evaporator further includes a pair of parallel, spaced headers and a plurality of parallel, spaced microchannel tubes extending between the headers with ends of the tubes received in the headers for the transfer of refrigerant between the tubes and the headers. Each of the tubes defines one of the microchannel tube legs. According to a further feature, each of the headers extends along a longitudinal axis and includes a plurality of spaced, elongate tube receiving slots, with each slot receiving an end of the microchannel tubes. The slots are formed at a non-perpendicular angle with the longitudinal axis of the header, and the side walls share the non-perpendicular angle to allow for gravity assisted ejection of the cubes from the compartments with the longitudinal axis extending in a vertical direction.

[0010] According to one feature, the ice cube tray evaporator further includes a microchannel tube extending in a serpentine shape to define the microchannel tube legs of the grid. As a further feature, the ice cube tray evaporator further includes an inlet manifold connected to one end of the microchannel tube to deliver refrigerant thereto, and an outlet manifold connected to the other end of the microchannel tube to receive refrigerant therefrom.

[0011] In accordance with one feature, the other two side walls of each compartment are defined by elongate strips of heat conductive material.

[0012] As one feature, the microchannel tube legs and the back wall are made of aluminum material. As a further feature, the microchannel tube legs and the back wall are plated with nickel.

[0013] In one feature, the microchannel tube legs are brazed to the back wall.

[0014] According to one feature, the grid is a first grid of ice cube forming compartments, and the ice cube tray evaporator further includes a second grid of ice cube forming compartments, with the first and second grids facing in opposite directions in a back-to-back configuration.

[0015] In accordance with one feature, the back plate is a microchannel tube.

[0016] As one feature, the microchannel tube legs are brazed to the back wall.

[0017] In accordance with one feature of the invention, a method is provided for making an ice cube tray evaporator. The method includes the step of brazing a plurality of spaced, microchannel tube legs to a back plate to form a grid of ice cube forming compartments having the tube legs as side wall.

[0018] In one feature, the brazing step is an aluminum brazing step.

[0019] According to one feature, the brazing step includes brazing a pair of elongate, parallel spaced headers to ends of each of the tube legs.

[0020] As one feature, the method further includes the step of forming an elongate microchannel tube into a serpentine configuration to define the tube legs of the grid prior to the step of brazing.

[0021] In accordance with one feature, the method further includes the step of nickel plating the tube legs and back plate after the step of brazing.

[0022] Additional objects and/or features of the invention can best be understood by a detailed reading of the entire specification, including the appended claims and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. **1** is a perspective view of an ice cube tray evaporator embodying the present invention;

[0024] FIG. **2** is an exploded view of the ice cube tray evaporator of FIG. **1**;

[0025] FIGS. **3-7** are perspective views showing alternate embodiments of ice cube tray evaporators embodying the present invention; and

[0026] FIG. **8** is a section view of a microchannel tube that can be utilized in each of the embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0027] With reference to FIGS. **1** and **2**, an ice cube tray evaporator **10** includes a back plate **12** and a grid **14** of rectangular-shaped ice cube forming compartments **16** on the back plate **12**. Each of the compartments **16** is defined by a back wall **18** (the portion of the back plate underlying the compartment **16**), and four side walls **20**, **22**, **24** and **26**, with two of the side walls **20** and **22** being defined by parallel microchannel tube legs **28** spaced opposite from each other and the other two of the side walls **24** and **26** being defined by heat conductive strips **30**. Each of the strips **30** has a plurality of tube leg-receiving slots **31** that allow the strip to be assembled onto the tube legs **28**. In this regard, it is preferred that each of the slots closely conform to the exterior shape of the corresponding tube leg **28**.

[0028] In the embodiment of FIGS. **1** and **2**, the ice cube tray evaporator **10** includes a pair of parallel spaced headers **32** and **34**, and each of the microchannel tube legs **28** is defined by one of a plurality of parallel spaced microchannel tubes **36** extending between the headers **32** and **34**, with ends **38** of the tubes **36** being received in corresponding elongate tube slots **40** formed in the headers **32** and **34** for the transfer of refrigerant between the tubes **36** and the headers **32** and **34**. As best seen in FIG. **2**, each of the headers **32**,**34** extends along a longitudinal axis **42**, and preferably each of the elongate tube receiving slots **40** is formed at a nonperpendicular angle (15° from perpendicular in the illustrated embodiment) with the longitudinal axis **40** of the header, which positions each of the tubes **36** and corresponding side walls **20** and **22** at the same nonperpendicular angle to allow for gravity assisted ejection of the ice cubes from the compartments **16** when the longitudinal axis **42** extends in a vertical direction and the tube legs **28** extend in a horizontal direction. The headers **32**,**34** include inlet or outlet ports **50** and **52** and end caps **54**, all of which can be of any suitable construction.

[0029] FIG. **3** shows an alternate embodiment of the ice cube tray evaporator **10** that differs from the embodiment **10** of FIGS. **1** and **2** in that it is designed so that the tubes **36** and corresponding side walls **20** and **22** and tube legs **28** extend vertically, rather than horizontally. In this regard, it is preferred that the strips have a nonperpendicular angle with the vertical axis (15° from perpendicular in the illustrated embodiment), rather than the tubes **36** and associated tube slots **40** in the headers which can be perpendicular to the axis **42** in the embodiment of FIG. **3**.

[0030] FIG. **4** shows yet another embodiment of the ice cube tray evaporator **10** similar to the embodiment of FIG. **3**, except the microchannel tube legs **28** are defined by a continuous microchannel tube **54** that has been shaped into a serpentine pattern, rather than individual tubes **36** as in FIG. **3**, and the headers **50** and **52** are replaced by manifolds **56** and **58** provided at each end of the tube **54** to direct refrigerant to and from the tube **54**. In the illustrated embodiment, the tube legs **28** are intended to extend in the vertical direction with the strips **30** having the nonperpendicular angle (15° from perpendicular in the illustrated embodiment) with the vertical direction in the same fashion as the embodiment of FIG. **3**.

[0031] FIG. **5** shows yet another embodiment of the ice cube tray evaporator **10** that is similar to the embodiment of FIG. **3**, except that the back plate **12** is provided in the form of one large microchannel tube **60** that is supplied refrigerant by a pair of spaced elongate headers **62** and **64** having inlet and outlet ports **66** and **68** similar to the ports **50** and **52**.

[0032] FIG. **6** shows another embodiment of the ice cube tray evaporator **10** that is similar to the embodiment of FIG. **4** except for the provision of another grid **70** of ice cube forming compartments **16** that is provided on an opposite side of the back plate **12** from the grid **14** so that the grids **14** and **70** face opposite directions in a back-to-back configuration. The grid **70** is formed using another one of the serpentine tubes **54**, with the additional tube **54** being fed by the manifolds **56** and **58**.

[0033] FIG. **7** shows an embodiment having an additional grid **72** similar to the embodiment of FIG. **6**, but formed of the parallel tube-type construction of FIG. **3**.

[0034] It should be understood that in each of the embodiments of FIGS. **1**, **4**, **6** and **7**, the back plate **12** could be provided in the form of a large microchannel tube similar to the embodiment of FIG. **5**.

[0035] As another option for the embodiments of FIGS. **1**-**3**, **5** and **7**, one or more baffles can be inserted into the headers **32** and **34** to provide multi-passing of the refrigerant through banks of the tubes **36**.

[0036] FIG. **8** is a somewhat diagrammatic view of a cross section of a microchannel tube **73**, as could be used for the tube legs **28** or the back plate **12**, and illustrates that the tube has an essentially flat cross section with a plurality of microchannels or ports **74** extending in the longitudinal direction. It should be understood that are a number of possible configurations for the ports **74** and that the particular configuration shown will be highly dependent upon the requirements of each application. It should also be understood that in embodiments that incorporate a microchannel tube in the back plate **12**, the ports **74** in the back plate **12** may be of a different configuration than the ports **74** of the microchannel tube legs **28**. Furthermore, it may be desirable in some applications to vary the port configurations from microchannel tube leg **28** to microchannel tube leg **28**, or even potentially within a microchannel tube leg **28**.

[0037] While any suitable materials can be used for the components of the above-described ice cube tray evaporators **10**, aluminum is a preferred material, with all of the joints being braze joints that are formed in a single oven braze operation. In this regard, it may be desirable for some or all of the components, such as the headers, tube legs, or strips, to be formed of an aluminum braze clad material to assist in the brazing. It is preferred that the microchannel tube legs **28** be brazed to the back plate **12**, and the same holds true for the strips **30**. After brazing, the ice cube tray evaporator **10** can be nickel-plated to meet FDA regulations for pottable water and ice making.

[0038] It should be appreciated that the disclosed ice cube tray evaporators **10** can provide a construction that is relatively easy to manufacture, and when made from aluminum, a construction that can easily have a lower cost than current technology ice cube tray evaporators made from copper. Additionally, it should also be appreciated that the use of microchannel tubes can allow for the ice cube tray evaporator **10** to be used with higher pressure systems such as CO_2 systems, as well as with more conventional lower pressure systems, thereby allowing the ice cube tray evapo-

rators **10** to be used with a larger variety of refrigerants in comparison to conventional constructions. It should also be appreciated that the use of microchannel tubes can also reduce the internal volume of the ice cube tray evaporators **10** in comparison to current technology ice cube tray evaporators, thereby reducing the cost of refrigerant to fill the system and some potential risk associated with flammable refrigerants. Also, the use of microchannel tubes can provide quicker cycle times, which include freezing of water in a shortened defrost cycle to remove the ice cubes, in comparison to conventional ice cube tray evaporators.

1. An ice cube tray evaporator comprising a grid of ice cube forming compartments, each compartment defined by a back wall and four side walls, two of the side walls defined by microchannel tube legs spaced opposite from each other.

2. The ice cube tray evaporator of claim **1** further comprising a pair of parallel, spaced headers and a plurality of parallel, spaced microchannel tubes extending between the headers with ends of the tubes received in said headers for the transfer of refrigerant between the tubes and the headers, each of the tubes defining one of the microchannel tube legs.

3. The ice cube tray evaporator of claim **2** wherein each of the headers extends along a longitudinal axis and comprises a plurality of spaced, elongate tube receiving slots, each slot receiving an end of the microchannel tubes, the slots formed at a non-perpendicular angle with the longitudinal axis of the header, said side walls sharing the non-perpendicular angle to allow for gravity assisted ejection of the cubes from the compartments with the longitudinal axis extending in a vertical direction.

4. The ice cube tray evaporator of claim **1** further comprising a microchannel tube extending in a serpentine shape to define the microchannel tube legs of the grid.

5. The ice cube tray evaporator of claim **4** further comprising an inlet manifold connected to one end of the microchannel tube to deliver refrigerant thereto, and an outlet manifold connected to the other end of the microchannel tube to receive refrigerant therefrom.

6. The ice cube tray of claim **1** wherein the other two side walls of each compartment are defined by elongate strips of heat conductive material.

7. The ice cube tray evaporator of claim **1** wherein the microchannel tube legs and the back wall are made of aluminum material.

8. The ice cube tray evaporator of claim **7** wherein the microchannel tube legs and the back wall are plated with nickel.

9. The ice cube tray evaporator of claim **8** wherein the microchannel tube legs are brazed to the back wall.

10. The ice cube tray evaporator of claim **1** wherein the back wall of each compartment is defined by a microchannel tube.

11. The ice cube tray evaporator of claim **1** wherein said grid is a first grid of ice cube forming compartments, and further comprising a second grid of ice cube forming compartments, the first and second grids facing in opposite directions in a back-to-back configuration.

12. An ice cube tray evaporator comprising:

a back plate; and

a grid of ice cube forming compartments on the back plate, each compartment defined by the back plate and four side walls, two of the side walls defined by microchannel tube legs spaced opposite from each other.

13. The ice cube tray evaporator of claim **12** wherein the back plate is a microchannel tube.

14. The ice cube tray evaporator of claim **13** further comprising a pair of parallel, spaced headers and a plurality of parallel, spaced microchannel tubes extending between the headers with ends of the tubes received in said headers for the transfer of refrigerant between the tubes and the headers, each of the tubes defining one of the microchannel tube legs.

15. The ice cube tray evaporator of claim **14** wherein each of the headers extends along a longitudinal axis and comprises a plurality of spaced, elongate tube receiving slots, each slot receiving an end of the microchannel tubes, the slots formed at a non-perpendicular angle with the longitudinal axis of the header, said side walls sharing the non-perpendicular angle to allow for gravity assisted ejection of the cubes from the compartments with the longitudinal axis extending in a vertical direction.

16. The ice cube tray evaporator of claim **14** further comprising a microchannel tube extending in a serpentine shape to define the microchannel tube legs of the grid.

17. The ice cube tray evaporator of claim **16** further comprising an inlet manifold connected to one end of the microchannel tube to deliver refrigerant thereto, and an outlet manifold connected to the other end of the microchannel tube to receive refrigerant therefrom.

18. The ice cube tray of claim **13** wherein the other two side walls of each compartment are defined by elongate strips of heat conductive material.

19. The ice cube tray evaporator of claim **13** wherein the microchannel tube legs and the back wall are made of aluminum material.

20. The ice cube tray evaporator of claim **19** wherein the microchannel tube legs and the back wall are plated with nickel.

21. The ice cube tray evaporator of claim **20** wherein the microchannel tube legs are brazed to the back wall.

22. The ice cube tray evaporator of claim **13** wherein said grid is a first grid of ice cube forming compartments, and further comprising a second grid of ice cube forming compartments, the first and second grids facing in opposite directions in a back-to-back configuration.

23. A method of making an ice cube tray evaporator, the method comprising the step of brazing a plurality of spaced, microchannel tube legs to a back plate to form a grid of ice cube forming compartments having the tube legs as side wall.

24. The method of claim **23** wherein the brazing step is an aluminum brazing step.

25. The method of claim **23** wherein the brazing step includes brazing a pair of elongate, parallel spaced headers to ends of each of said tube legs.

26. The method of claim **23** further comprising the step of forming an elongate microchannel tube into a serpentine configuration to define the tube legs of the grid prior to the step of brazing.

27. The method of claim **23** further comprising the step of nickel plating the tube legs and back plate after the step of brazing.

* * * * *