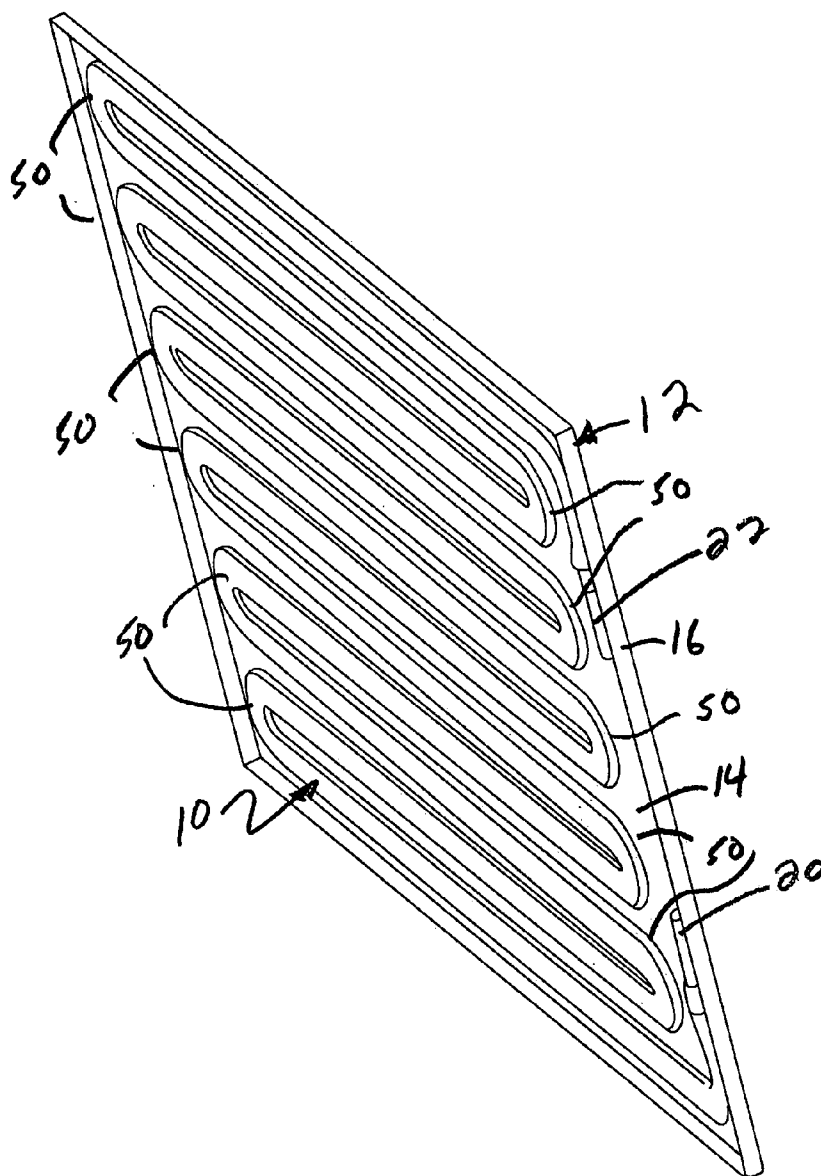




US 20080302518A1

(19) **United States**(12) **Patent Application Publication**
Durdel et al.(10) **Pub. No.: US 2008/0302518 A1**(43) **Pub. Date: Dec. 11, 2008**(54) **FLAT TUBE HEAT EXCHANGER****Publication Classification**(76) Inventors: **Joseph Durdel**, Sigel, IL (US);
Kevin Gurley, Effingham, IL (US);
James Siemer, Effingham, IL (US);
Michael Warkins, Vernon Hills, IL (US)(51) **Int. Cl.**
F28D 1/00 (2006.01)(52) **U.S. Cl.** **165/148**Correspondence Address:
BRINKS HOFER GILSON & LIONE
NBC Tower
Suite 3600, 455 N. Cityfront Plaza Drive
Chicago, IL 60611-5599 (US)(57) **ABSTRACT**

A flat tube heat exchanger is provided including a first flat side and a second flat side opposite the first flat side joined together by two opposing sides. At least one internal partition defines a flow duct within the interior of the heat exchanger. A bend is provided in the plane substantially defined by the first flat side.

(21) Appl. No.: **11/810,944**(22) Filed: **Jun. 7, 2007**

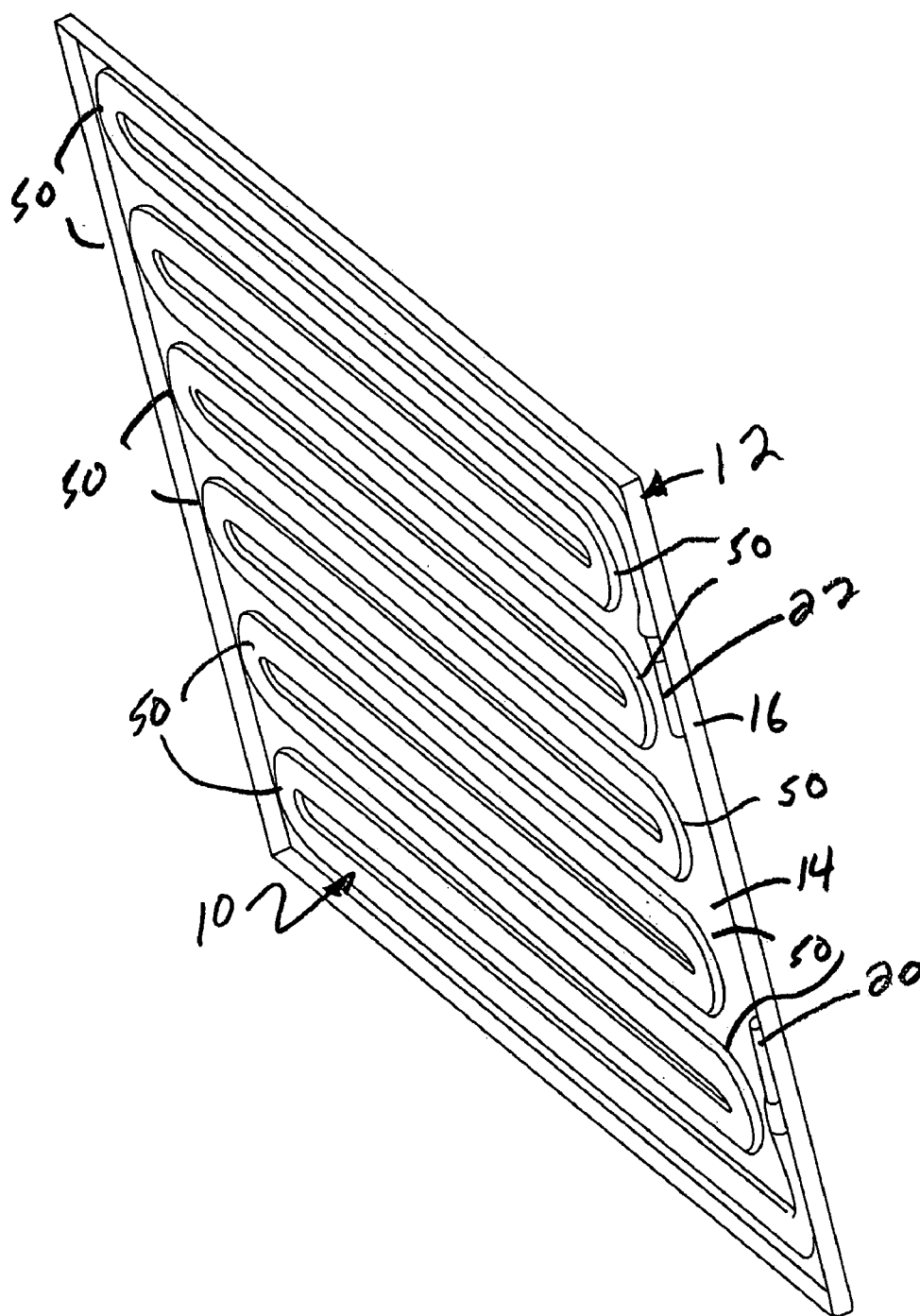


Fig. 1

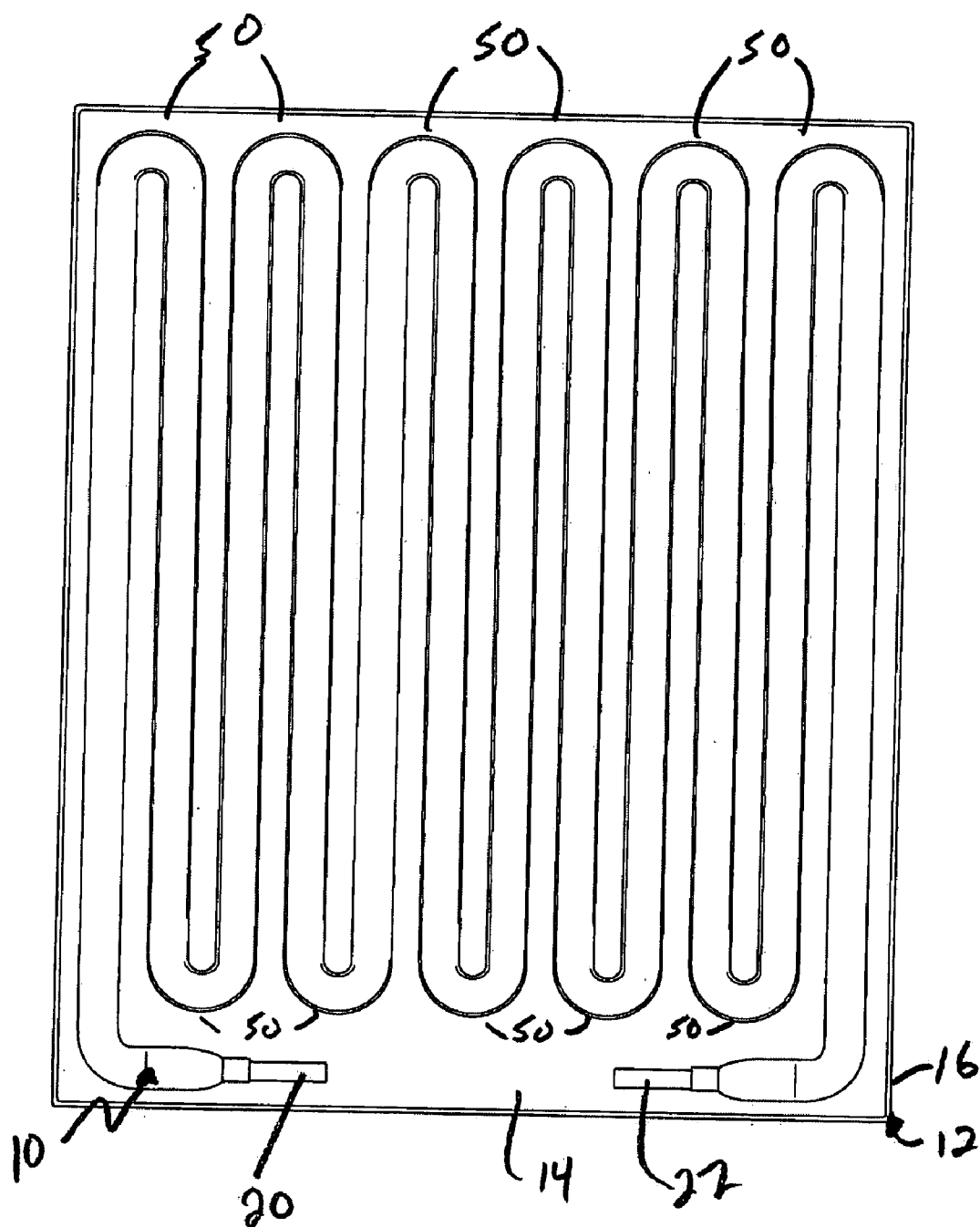


Fig. 2

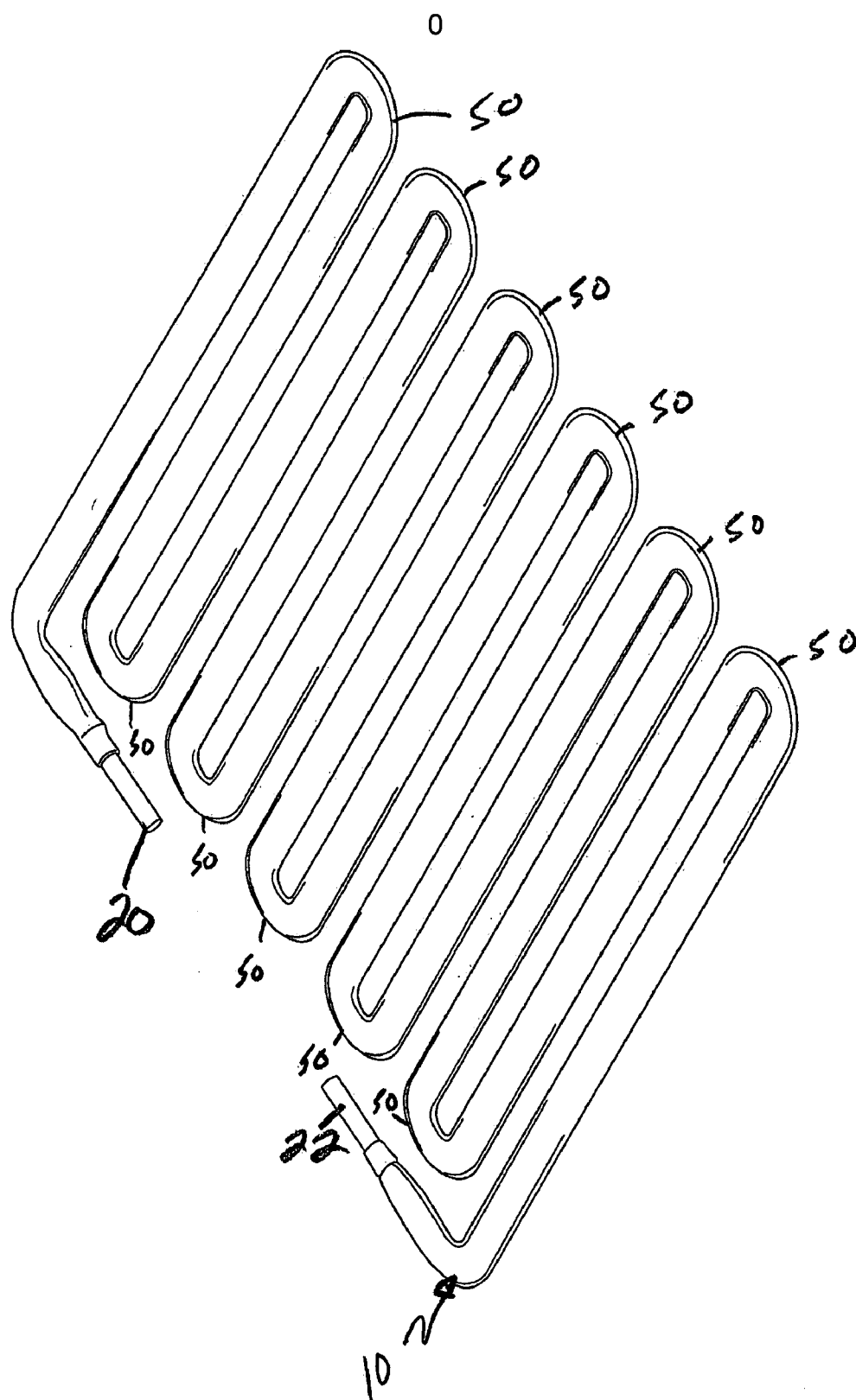


Fig. 3

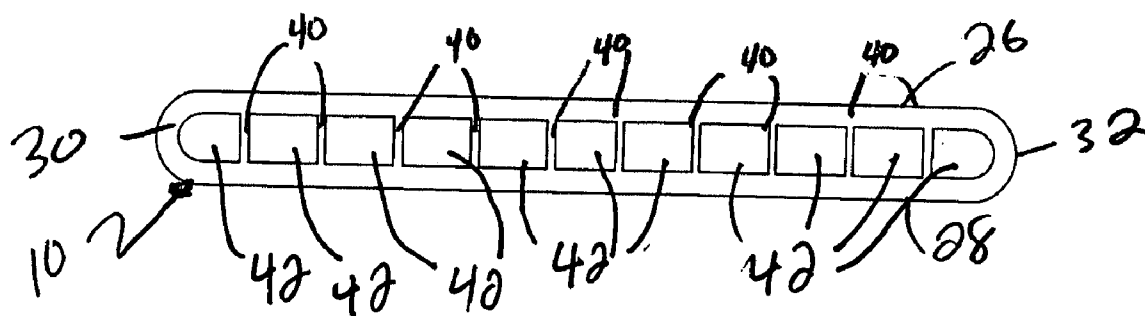


Fig. 4

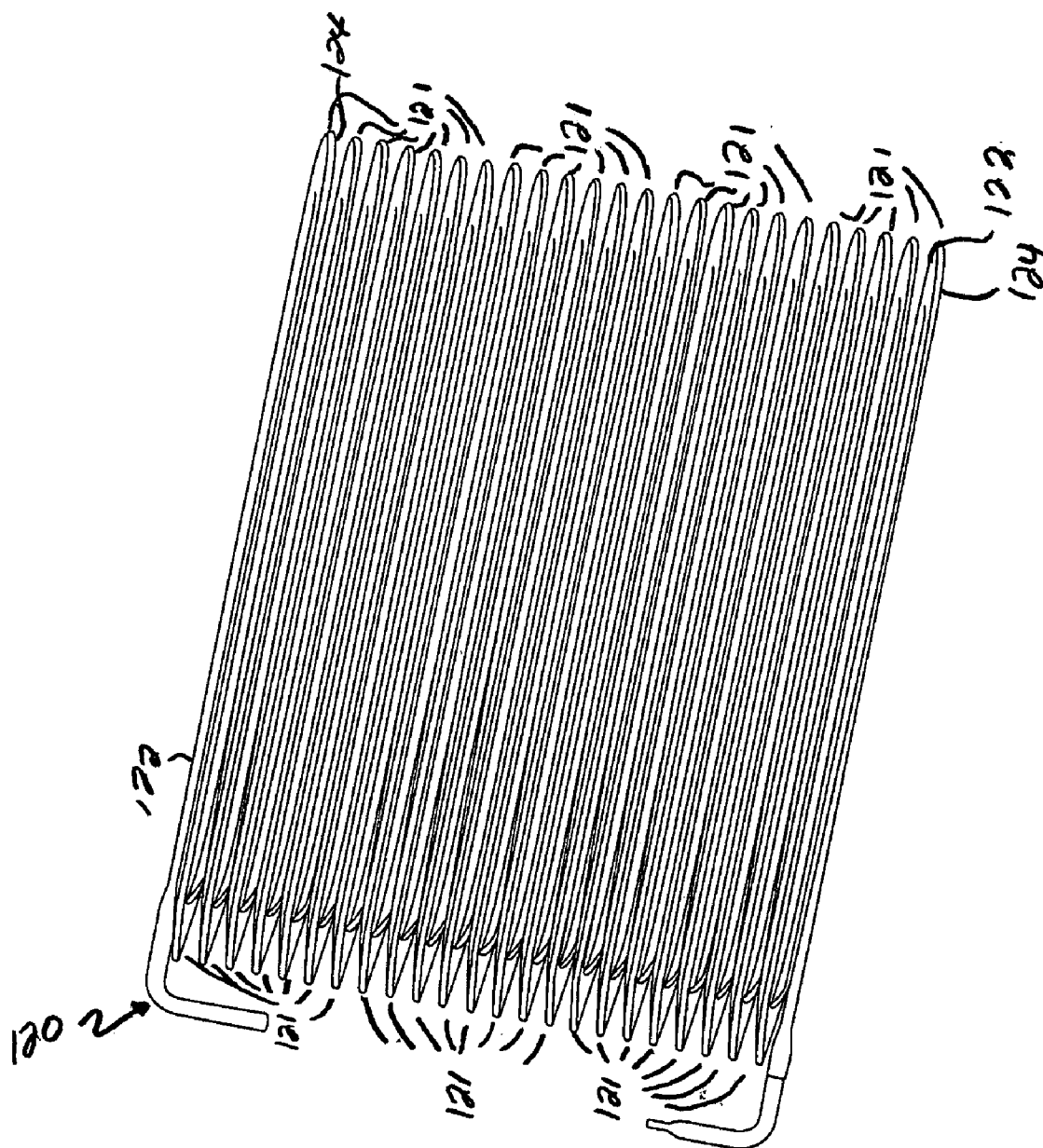


Fig. 5

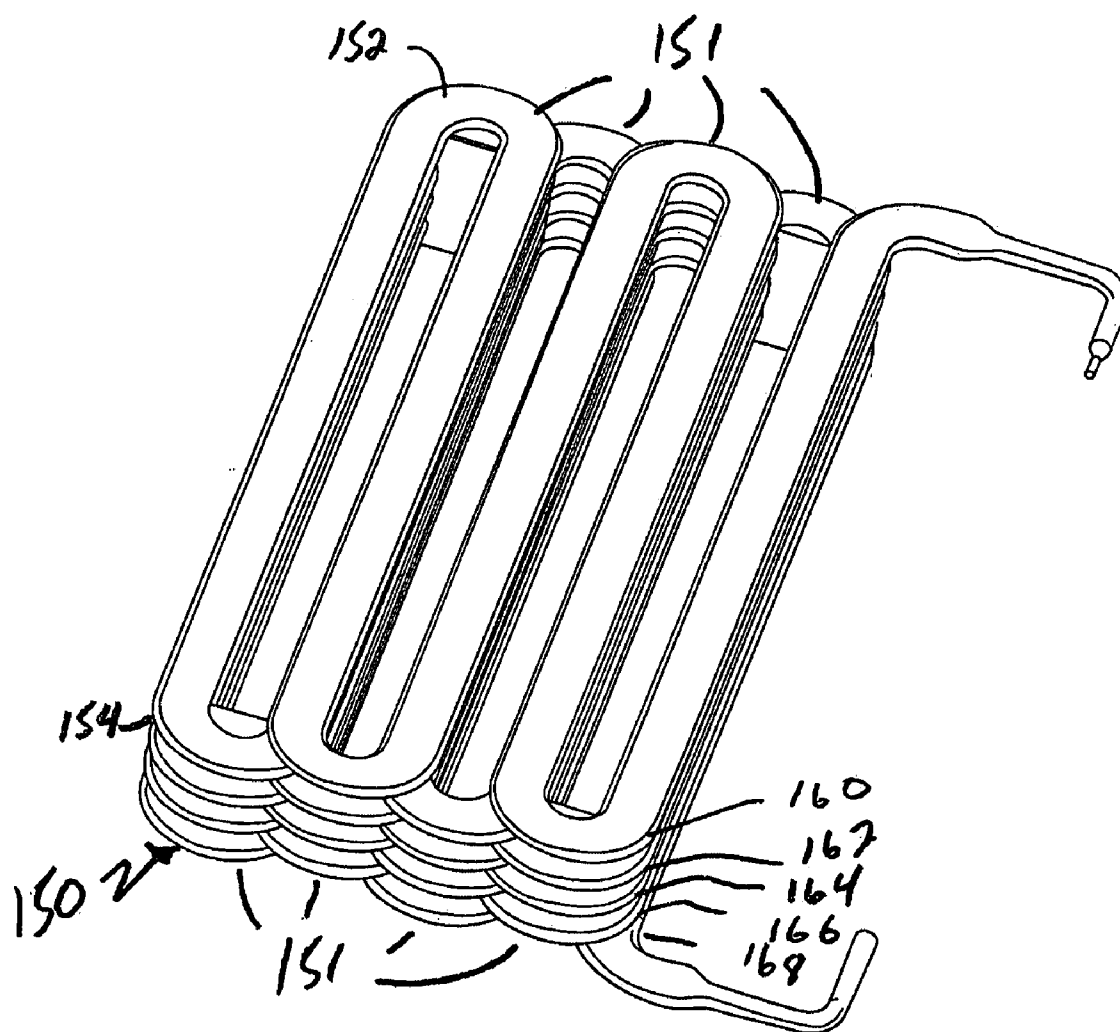


Fig. 6

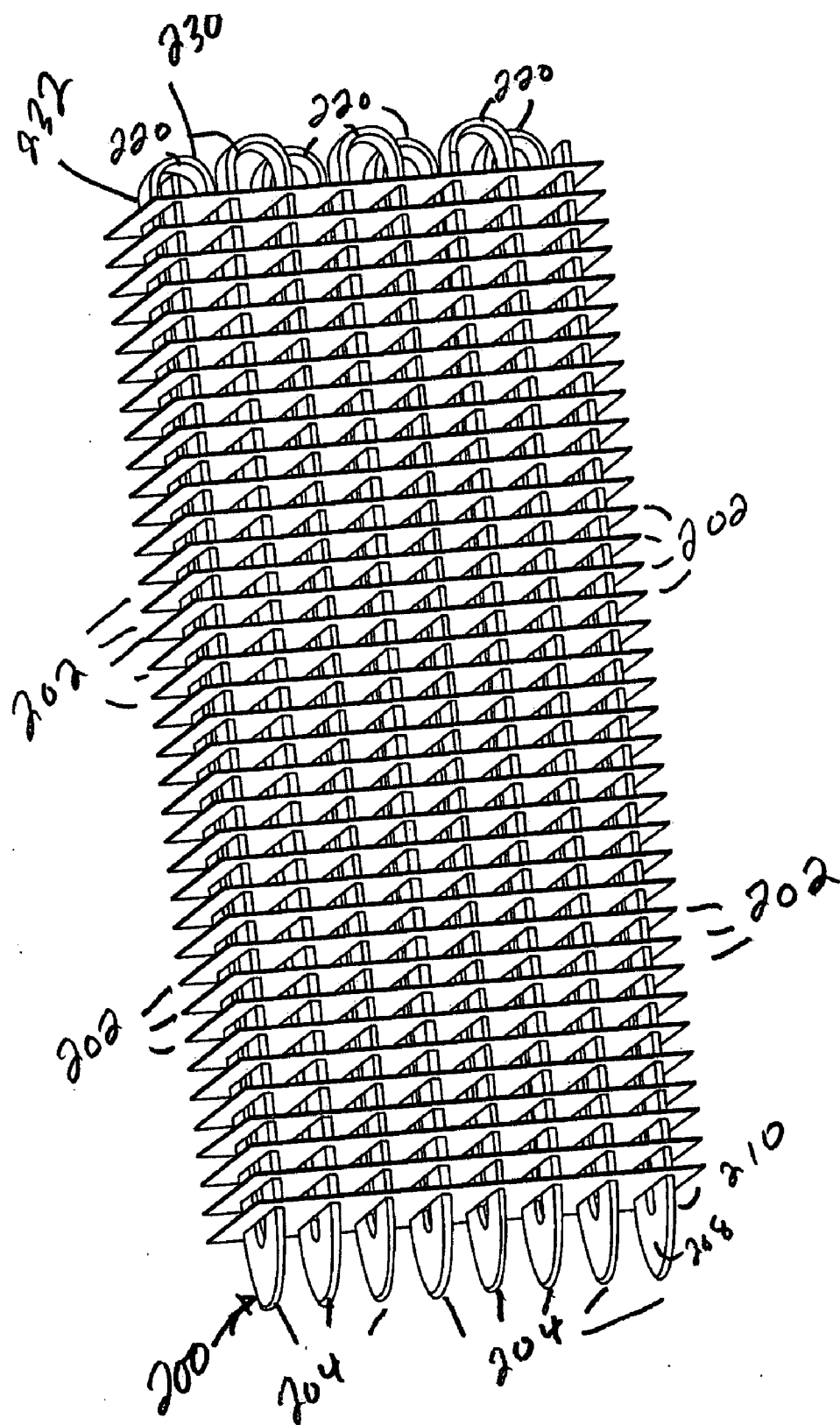


Fig. 7

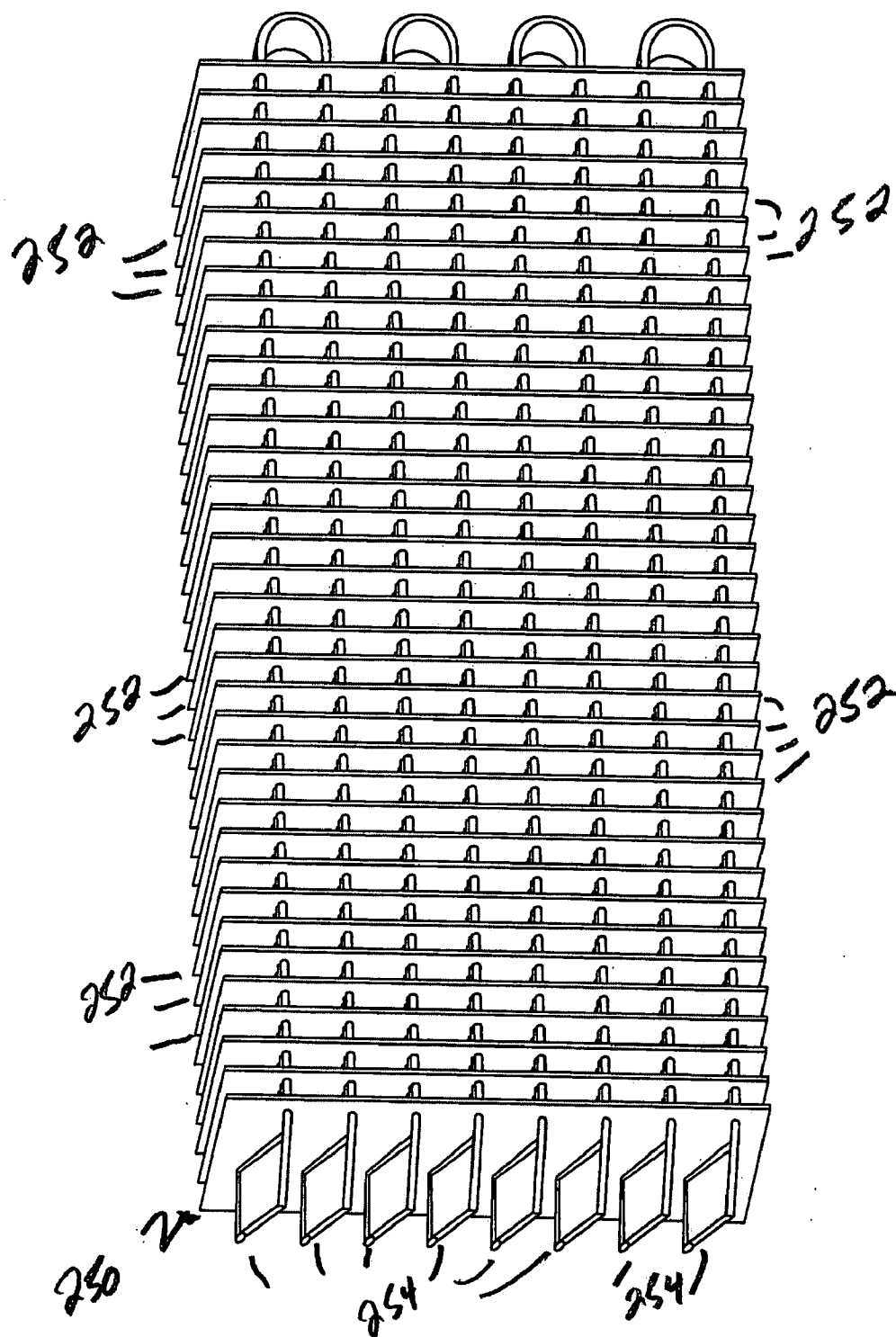


Fig. 8

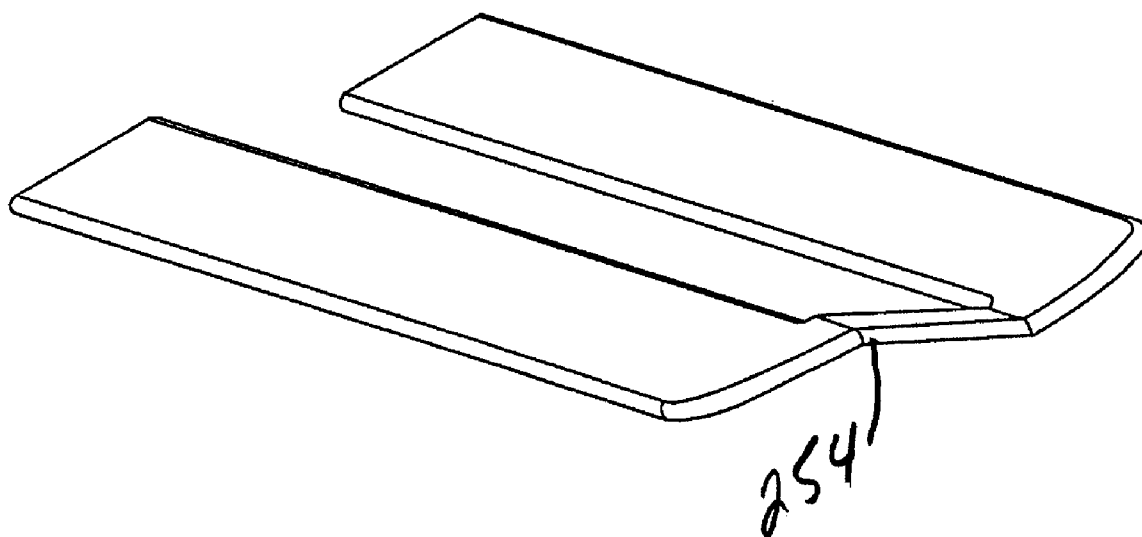


Fig. 9

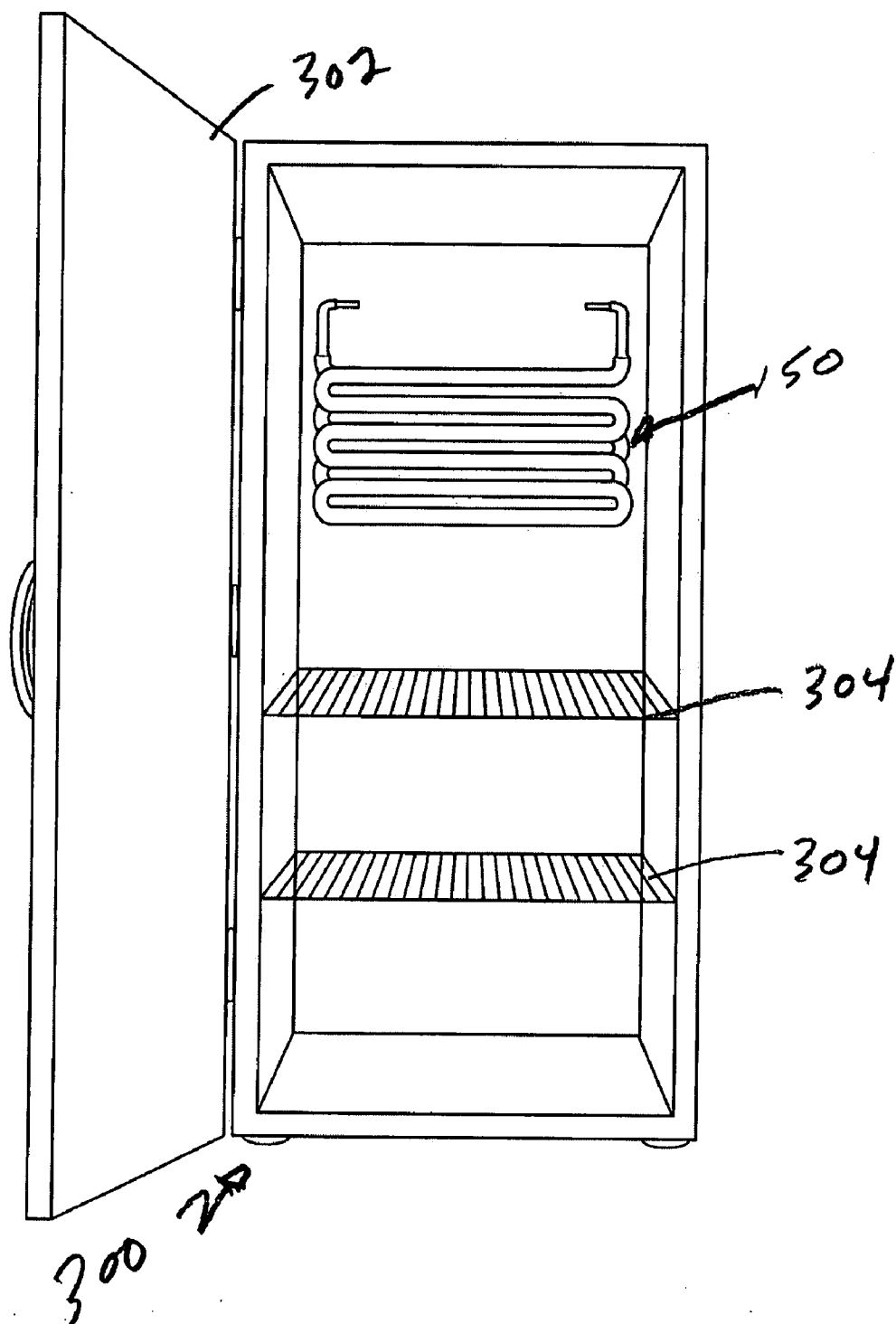


Fig. 10

FLAT TUBE HEAT EXCHANGER

FIELD OF THE INVENTION

[0001] The present invention relates generally to the field of heat exchangers. More specifically, the present invention relates to a flat tube heat exchanger having a bend in the plane of a flat side of the tube.

BACKGROUND OF THE INVENTION

[0002] Heat exchanger coils have been used for many years in various refrigeration systems. Heat exchanger coils have traditionally been formed with round tubing. The coils can be configured in variety of shapes to suit the needs of a particular application. One example of the use of such heat exchanger coils is in refrigerators or reach-in coolers for presenting food and/or beverages items to customers while maintaining the food and/or beverage items in a refrigerated environment. Such reach-in coolers can include a shelf on which food items are stored. In one conventional practice, a heat exchanger coil of round tubing is connected to the bottom of the shelf/plate on which the food/beverage items are stored. A suitable refrigerant is passed through the heat exchanger to act as a heat exchange medium. The refrigerant in the heat exchange coil absorbs heat from the shelf and causes the refrigerant to evaporate as it passes through the heat exchanger. As a result, the temperature of the shelf is reduced, thereby keeping the items placed on the top surface thereof at a reduced temperature.

[0003] Heat exchanger coils having a flat tube configuration have also been formed for particular applications. Flat tube heat exchanger coils have been formed with two opposing flat sides and two interconnecting sides. In order to form a heat exchanger structure, a bend was placed in a plane defined by the interconnecting sides. It was understood that the bend would have to be formed in this manner because the material forming the tube would fracture if the bend was placed in a plane formed by the opposing flat sides.

[0004] Improvements have been sought in many heat exchangers which decrease the amount of necessary refrigerant materials. Also, improvements have been sought which would increase the heat transfer surface area of the heat exchanger coil in order to increase the efficiency of the system. As a result, there is a need for an improved heat exchanger tubing that assists in increasing the efficiency of the system while not adding undesirable features such as air restriction and excess material.

SUMMARY OF THE INVENTION

[0005] The present invention is directed to a flat tube heat exchanger tube that has improved efficiencies over heat exchanger tubes of the past. The present invention provides a flat tube heat exchanger that increases the heat transfer surface area while minimizing the internal cross-section of the tube, thereby minimizing the use of refrigerant within the heat exchanger tube. The flat tube heat exchanger of the present invention forms a novel shape offering improved air flow capabilities over the heat exchanger and a larger primary heat transfer surface for improved efficiency. The present invention also provides for an increased usable primary surface area, reduced secondary surface requirement, reduced air restriction, fewer braze joints, and reduced thermal resistance.

[0006] The present invention provides in one aspect, a flat tube heat exchanger including a first flat side and a second flat side opposite the first flat side joined together by two opposing sides. At least one internal partition defines a flow duct within the interior of the heat exchanger. A bend is provided in the plane substantially defined by the first flat side.

[0007] The present invention provides, in another aspect, a flat tube heat exchanger formed from a single one piece element having a first flat side and a second flat side opposite the first flat side and joined together by two opposing sides. At least one internal partition is provided to define a flow duct. The first flat side and second flat side define a width axis. The two opposing sides define a height axis. The flat tube heat exchanger has a U-shaped bend extending substantially around the height axis.

[0008] The present invention, together with attendant objects and advantages, will be best understood with reference to the detailed description below in connection with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is an illustration of a bottom perspective view of a flat tube heat exchanger connected to a plate according to an embodiment of the invention;

[0010] FIG. 2 is a bottom view of the flat tube heat exchanger and plate of FIG. 1;

[0011] FIG. 3 is a perspective view of the flat tube heat exchanger of FIGS. 1 and 2 without the plate;

[0012] FIG. 4 is a cross-sectional view of the flat tube heat exchanger of FIG. 1;

[0013] FIG. 5 is an illustration of a flat tube heat exchanger in accordance with a second embodiment of the present invention in the form of a helix;

[0014] FIG. 6 is an illustration of a flat tube heat exchanger in accordance with a third embodiment of the present invention in a layered form;

[0015] FIG. 7 is an illustration of a flat tube heat exchanger with a fin set in accordance with a fourth embodiment of the present invention;

[0016] FIG. 8 is an illustration of a flat tube heat exchanger with a fin set in accordance with a fourth embodiment of the present invention with offset tubes;

[0017] FIG. 9 is an enlarged view of a portion of the flat tube heat exchanger of FIG. 8 illustrating the offset tubes; and

[0018] FIG. 10 is an illustration of a refrigerator with the flat tube heat exchanger of FIG. 6 mounted therein.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] The present invention is directed to a flat tube heat exchanger useful in many different environments where heat transfer is necessary, such as refrigeration systems, radiators, oil coolers, air coolers, condensers, evaporators and heat sinks. For example, while the drawing of the embodiment of the present invention illustrates the use of an embodiment of the flat tube heat exchanger in a refrigeration environment, the present invention can be used in other types of heat transfer, such as air to liquid, air to air, liquid to liquid, or liquid to air. The flat tube heat exchanger of the present invention can take a wide variety of shapes and sizes beyond the specific embodiment illustrated in the present invention. Further, the heat transfer may take place in either direction depending upon the application.

[0020] A first embodiment of the flat tube heat exchanger 10 of the present invention is illustrated in FIGS. 1-4. With reference to FIG. 1, a bottom perspective view of a flat tube heat exchanger 10 connected to a plate 12 is illustrated. The plate 12 can act as a shelf in a refrigerator or reach-in cooler for the storage of food/beverage items. The flat tube heat exchanger 10 operates in a conventional manner to cool the plate 12 with a suitable refrigerant being passed through the flat tube heat exchanger 10. The refrigerant in the flat tube heat exchanger 10 absorbs heat from the plate 12 and causes the refrigerant to evaporate as it passes through the flat tube heat exchanger 10. As a result, the temperature of the plate 12 is reduced thereby keeping the items placed on the top surface thereof at a reduced temperature.

[0021] The plate 12 includes a top surface (not shown), a bottom surface 14, and sides 16. The flat tube heat exchanger tube 10 is attached to the bottom of the plate 12 using conventional attachment elements such as a very high bonding double sided tape, an adhesive or other known conventional fastening mechanism.

[0022] The flat tube heat exchanger 10 is illustrated in a serpentine embodiment as best illustrated in FIG. 3. Two opposing connections 20, 22 provide an inlet and outlet for the refrigerant material. As illustrated in FIG. 4, the flat tube heat exchanger 10 includes a first flat side 26 and an opposing second flat side 28. The first flat side 26 and second flat side 28 are interconnected by the opposing sides 30, 32. As shown in FIG. 4, the flat tube heat exchanger 10 is longer on the first and second flat sides 26, 28 (the width) than on the opposing sides 30, 32 (the height). This configuration increases the primary surface area relative to the cross-sectional area of the tube, thereby providing improved heat transfer. In addition, this configuration minimizes the profile of the tube allowing it to be used in smaller areas. While it should be recognized the opposing sides 30, 32 are rounded, they may also take other shapes such as forming flat sides.

[0023] A series of internal partitions 40 are provided between the first flat side 26 and the second flat side 28. The flow ducts 42 form a passageway for refrigerant or other heat transfer medium through the flat tube heat exchanger 10. The present embodiment illustrates the use of eleven flow ducts 42. However, it should be recognized that the number of flow ducts may be selected to suit the needs of a particular application. The internal partitions 40 provide additional strength to the flat tube heat exchanger 10 and assist in the heat transfer function.

[0024] With reference to FIG. 3, the flat tube heat exchanger 10 includes eleven U-shaped return bends 50 that form the serpentine shape. The bends 50 are formed in a plane defined by the first flat side 26. The bends 50 are also formed around the height axis defined by the opposing sides 30, 32. It should be recognized that more than or fewer than eleven U-shaped return bends may be implemented to suit the needs of a particular application. The bends 50 can also be formed with an angle greater than or less than 180 degrees.

[0025] The flat tube heat exchanger 10 can be formed having a width in the range of 0.375 to 3 inches and with a tube thickness in the range of 0.062 to 0.5 inches. The wall thickness may depend on the material used to form the tube and the particular application. The flat tube heat exchanger 10 may be formed in a number of various lengths and widths and out of a number of various known materials, e.g., aluminum, as necessary to suit needs of the particular application.

[0026] The flat tube heat exchanger 10 is formed using a conventional serpentine type bender. The machine is equipped with tooling to support and minimize deformation of the manufactured tube bends, in order to retain it in a flat configuration. In particular, the flat tube heat exchanger is formed by crushing the tube into a radius formed block to maintain a consistent flow of material throughout the bend. Crushing compression is applied by a follow block formed to hold and shape the material flat and parallel to the heat exchanger. The tube is fully enclosed by the inside radius block and the follow-up block to maintain the overall tube dimensions and shape. The flat tube heat exchanger 10 is formed by bending the tube while simultaneously supporting the sides and radii.

[0027] FIG. 5 is an illustration of a flat tube heat exchanger 120 in accordance with a second embodiment of the present invention. The flat tube heat exchanger 120 is formed in the shape of a helix. Return bends 121 are formed substantially in a plane defined by at least one of the opposing flat sides 122, 124. The flat tube heat exchanger 120 is formed in essentially the same manner as flat tube heat exchanger 10 of FIGS. 1-4, with the exception that during the formation process, all bends are formed in the same direction. In addition, the flat tube heat exchanger 120 functions generally in the same way as the flat tube heat exchanger 10 of FIGS. 1-4 with the exception of the helix shape offering unique air flow characteristics that may be useful in certain applications. The flat tube heat exchanger 120 may be formed with a right hand or left hand rotation. The cross section of the spiral may take forms as known by those of ordinary skill in the art such as rectangular, round, oval, or other known shapes. In addition, the density of the helix shape may be altered to suit particular applications.

[0028] FIG. 6 is an illustration of a flat tube heat exchanger 150 in accordance with a third embodiment of the present invention. The flat tube heat exchanger 150 is formed in the shape of a layered symmetrical pattern. Return bends 151 are formed substantially in a plane defined by the opposing flat sides 152, 154. The flat tube heat exchanger 150 has a layered shape that is a combination of the serpentine and helical shape to create a multi-plane serpentine. The layers 160, 162, 164, 166, 168 may be formed in an aligned or staggered configuration. The flat tube heat exchanger 150 is formed in essentially the same manner as flat tube heat exchanger 10 of FIGS. 1-4, with the exception that during the formation process layers are introduced. In addition, the flat tube heat exchanger 150 functions generally in the same way as the flat tube heat exchanger 10 of FIGS. 1-4, with the exception of the overlay shape offering unique air flow characteristics that may be useful in certain applications.

[0029] FIG. 7 is an illustration of a flat tube heat exchanger 200 with a fin set 202 in accordance with a fourth embodiment of the present invention. The flat tube heat exchanger 200 is formed with return bends 204 formed substantially in a plane defined by at least one of the opposing flat sides 208, 210 or around the height axis. Return bends 220 are formed in a plane defined by the opposing sides 230, 232 or around the width axis. The flat tube heat exchanger 200 is formed in essentially the same manner as the flat tube heat exchanger 10 of FIGS. 1-4, with the exception that during the formation process, existing technology of returns 220 is used in combination with the new technology 204. In addition, the fin set 202 is also attached thereto. In addition, the flat tube heat exchanger 200 functions generally in the same way as the flat

tube heat exchanger **10** of FIGS. **1-4**, with the exception of the shape and fin set **202** offering unique air flow characteristics that may be useful in certain applications. It should be recognized that the present invention may be used with or without fins.

[0030] FIGS. **8-9** are an illustration of a flat tube heat exchanger **250** with a fin set **252** in accordance with a fifth embodiment of the present invention. The flat tube heat exchanger **250** has essentially the same configuration of FIG. **7**, with the exception of having offset return bends **254**. The flat tube heat exchanger **250** is formed in essentially the same manner as flat tube heat exchanger **200** of FIG. **7**, with the exception that during the formation process, a secondary process is used to offset the tubes. In addition, the flat tube heat exchanger **250** functions generally in the same way as the flat tube heat exchanger **200** of FIG. **7**, with the exception of the shape and fin set **252** offering unique air flow characteristics that may be useful in certain applications.

[0031] FIG. **10** is an illustration of refrigerator **300** with the flat tube heat exchanger **150** of FIG. **6** mounted therein and with the rear interior surface of the refrigerator removed. A door **302** and shelves **304** are illustrated. The flat tube heat exchanger **150** operates as explained herein to provide improved efficiencies over a conventional heat exchanger.

[0032] The embodiments described above and shown herein are illustrative and not restrictive. The scope of the invention is indicated by the claims rather than by the foregoing description and attached drawings. The invention may be embodied in other specific forms without departing from the spirit of the invention. For example, the overall configuration of the flat tube heat exchanger of the present invention may be designed and configured in a manner other than as specifically illustrated in the figures. In addition, the present invention may be used with or without fins. Accordingly, these and any other changes which come within the scope of the claims are intended to be embraced herein.

We claim:

1. A one piece flat tube heat exchanger comprising:
a first flat side and a second flat side opposite the first flat side, the first flat side and the second flat side joined together by two opposing sides, at least one internal partition to define a flow duct interconnecting the first flat side and the second flat side, the flat tube heat exchanger having a bend in a plane substantially defined by the first flat side whereby a flat tube heat exchanger is formed with the bend portion formed substantially coplanar with the first flat side.
2. The flat tube heat exchanger of claim **1** wherein the two opposing sides are rounded.
3. The flat tube heat exchanger of claim **1** wherein the flat tube heat exchanger has a serpentine pattern.

4. The flat tube heat exchanger of claim **1** wherein the bend forms a U-shape.

5. The flat tube heat exchanger of claim **1** wherein the flat tube heat exchanger has a helical pattern.

6. The flat tube heat exchanger of claim **1** wherein the flat tube heat exchanger has a layered pattern.

7. The flat tube heat exchanger of claim **6** wherein the flat tube heat exchanger has a layered pattern that is generally symmetric.

8. The flat tube heat exchanger of claim **1** wherein the flat tube heat exchanger further comprises another bend in a plane defined by at least one of the two opposing sides.

9. The flat tube heat exchanger of claim **8** wherein the flat tube heat exchanger further comprises a plurality of fins.

10. A flat tube heat exchanger, comprising:

a single one piece element including a first flat side and a second opposed flat side joined together by two opposing sides, at least one internal partition to define a flow duct, the flat tube heat exchanger having a width axis defined by the first flat side and the second flat side and a height axis defined by the two opposing sides, the flat tube heat exchanger having a U-shaped bend extending substantially around the height axis.

11. The flat tube heat exchanger of claim **10** wherein the two opposing sides are rounded.

12. The flat tube heat exchanger of claim **10** wherein the flat tube heat exchanger has a serpentine pattern.

13. The flat tube heat exchanger of claim **10** wherein the flat tube heat exchanger has a helical pattern.

14. The flat tube heat exchanger of claim **10** wherein the flat tube heat exchanger has a layered pattern.

15. The flat tube heat exchanger of claim **14** wherein the flat tube heat exchanger has a layered pattern that is generally symmetric.

16. The flat tube heat exchanger of claim **10** wherein the flat tube heat exchanger further comprises another bend extending around the width axis.

17. The flat tube heat exchanger of claim **16** wherein the flat tube heat exchanger further comprises a plurality of fins.

18. The flat tube heat exchanger of claim **10** wherein the flat tube heat exchanger is formed.

19. A refrigerator, comprising:

a flat tube heat exchanger tube formed as a one piece element including a first flat side and a second opposed flat side joined together by two opposing sides, at least one internal partition to define a flow duct, the flat tube heat exchanger having a U-shaped bend in the plane substantially defined by the first flat side.

20. The refrigerator of claim **19** wherein the bend forms a U-shape.

* * * * *