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3,368,615

HEAT EXCHANGER CONSTRUCTION

Filed Dec. 2, 1965

3 Sheets-Sheet 1

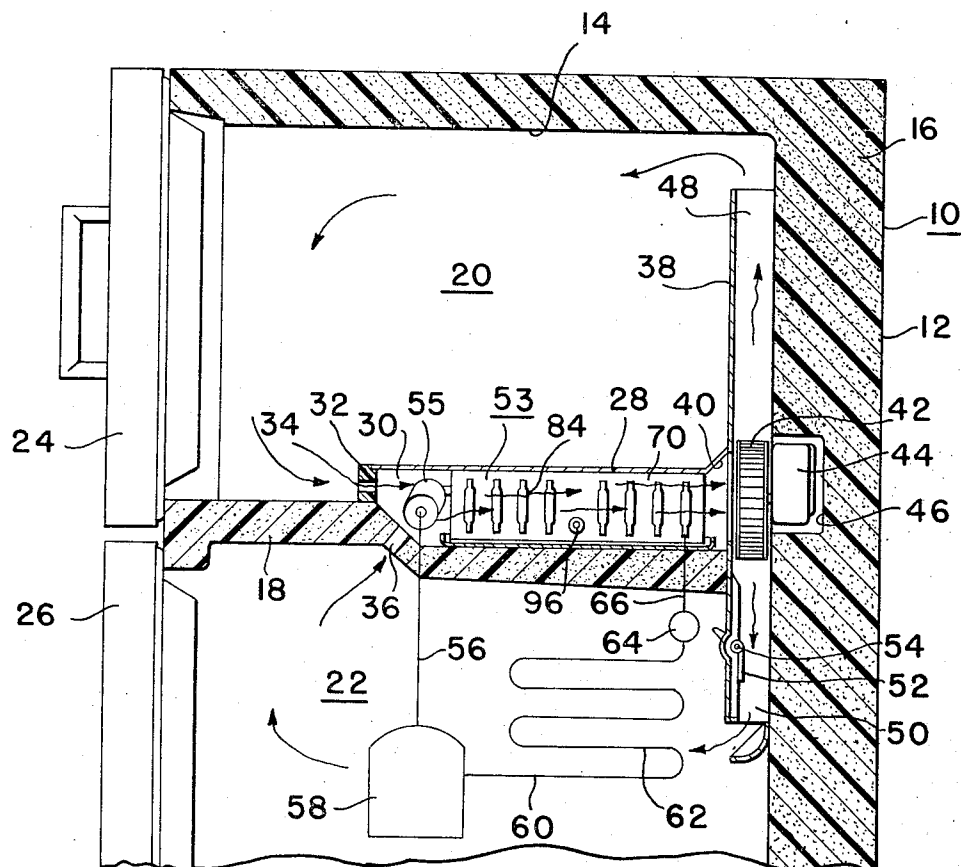


Fig. 1

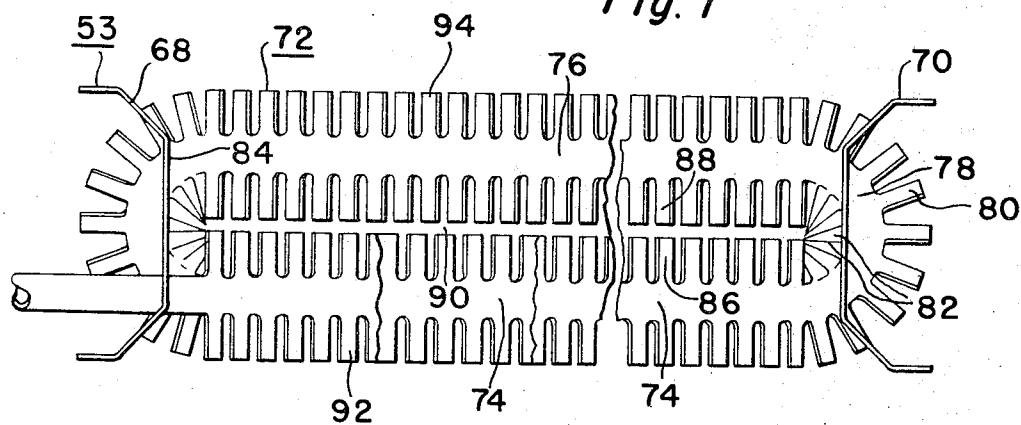


Fig. 2

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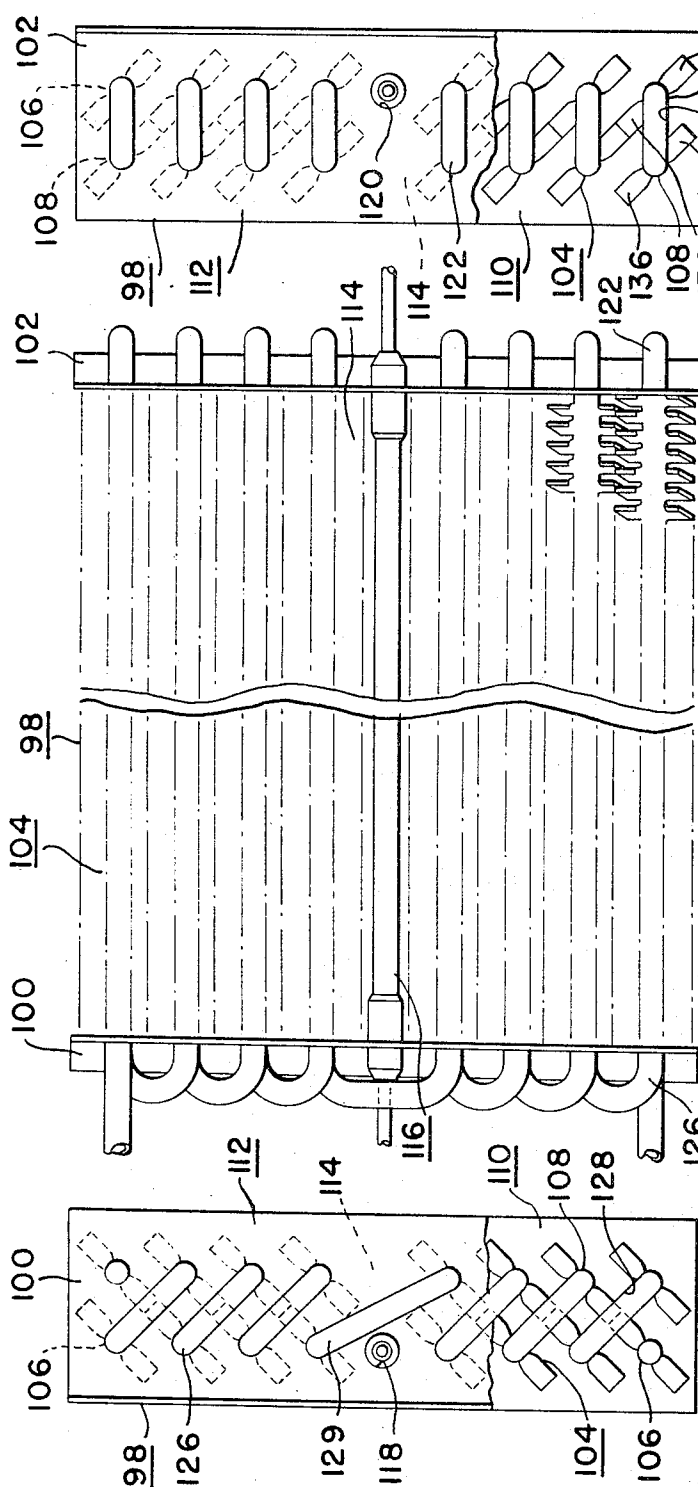


Fig. 4

Fig. 3

Fig. 5

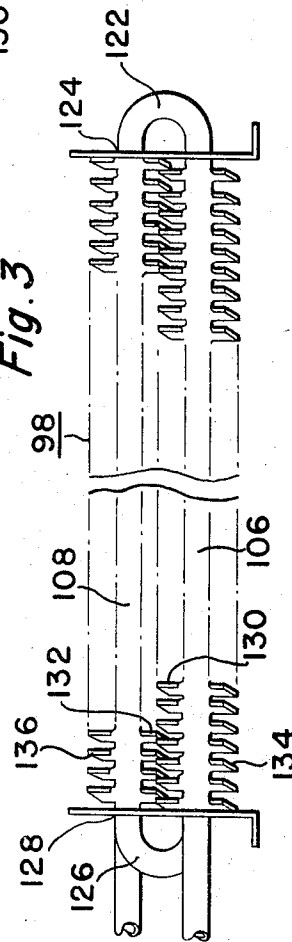


Fig. 6

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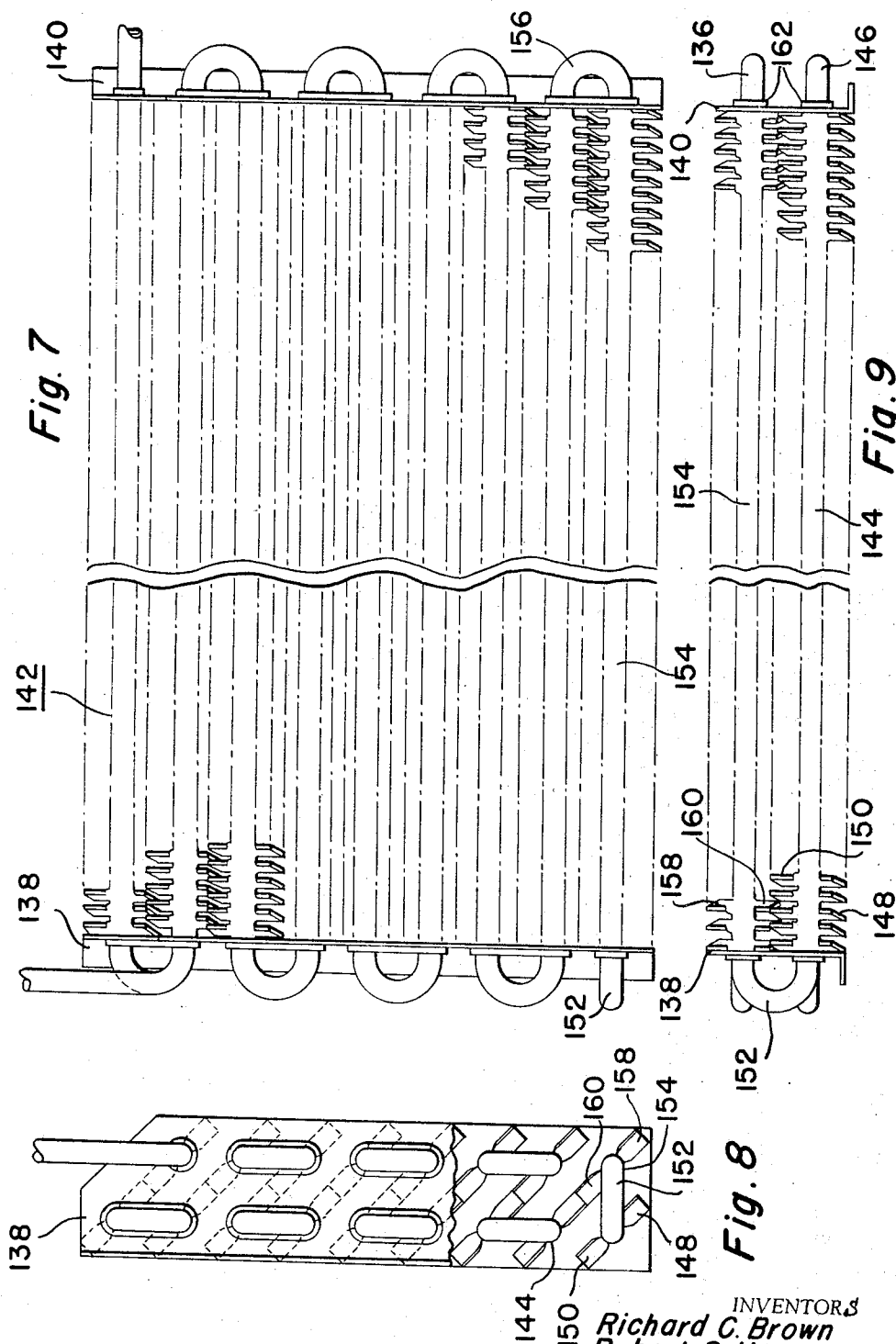
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3 Sheets-Sheet 3



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HEAT EXCHANGER CONSTRUCTION

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6 Claims. (Cl. 165-149)

ABSTRACT OF THE DISCLOSURE

In a preferred form, a three-piece heat exchanger construction including spaced-apart side members, a tube member having a plurality of upper and lower passes joined by a plurality of return bends to form a continuous fluid flow path, the side members supporting the return bend portions, each of the return bend portions and passes including a plurality of spaced-apart integral fins thereon, the spaced-apart integral fins on the return bends being located on the inner periphery thereof in engagement with one another to maintain a predetermined return bend radius, the passes being joined to the return bends to form a helical coil between the side members and the two passes being twisted along their length between the return bends to place the outwardly directed fins in intersecting relationship.

This invention is directed to domestic appliances and more particularly to an improved economical evaporator arrangement for association with air cooling domestic appliances such as refrigerators, air conditions and the like.

One problem in many air cooling domestic appliances is the fact that there is a relatively limited space in which to incorporate an evaporator for cooling air being circulated within the appliance. For example, in frost-proof refrigerators, one problem is to provide a large number of evaporator coil passes within the confines of the shell of the refrigerator and to include a large extended fin surface on the coils to provide an adequate heat exchange surface between the coil and air being circulated within the refrigerator. This is especially the case in frost-proof refrigerators where a primary air cooling stream is circulated over the evaporator to cool the air stream sufficiently to reduce its temperature to provide desired cooling in above-freezing and below-freezing compartments within the refrigerator. In such arrangements, it is also necessary to provide adequate clearance between adjacent fins on the evaporator coil so that frost buildup on the fins will not undesirably block air flow through the evaporator during normal refrigerating cycles of operation.

Similarly, in room air conditioners, there has been a definite tendency to reduce the outer dimensions of the air conditioning unit so that it will occupy less space as a window air conditioning unit or less space within a built-in wall type of installation. In such arrangements, the problem of including an evaporator coil within the limited dimensional configurations of the outer cabinet of the air conditioning unit is accentuated in that the evaporator must include a substantial extended heat transfer surface thereon to produce adequate cooling from the unit as the air is being circulated over the evaporator coil.

Accordingly, an object of the present invention is to improve an evaporator arrangement suitable for association with air cooling domestic appliances having reduced exterior dimensions by the provision of an economical three-piece evaporator construction including an integral fin and tube coil having return bend portions thereof supported by spaced apart side members and parallel passes with integral fins thereon that are located between the

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side members to occupy a reduced space between the top and bottom of the side wall members.

A further object of the present invention is to improve evaporator arrangements for association with air cooling domestic appliances by the provision of an economical three-piece evaporator including a continuously coiled integral fin and tube member having return bend portions with outwardly directed spaced apart fins thereon along the outer periphery thereof and a second plurality of fins on the inner radius of the return bend that are in engagement with one another to prevent undesirable collapsing of the return bend.

A further object of the present invention is to improve evaporator arrangements for air cooling domestic appliances by the provision of a continuously coiled integral fin and tube member that has spaced apart side members supportingly receiving return bend portions in the continuously coiled member and a plurality of parallel passes directed between the side members and twisted with respect to the return bend portions to align integral fins on the passes such that the end edges thereof are located in closely abutting relationship to reduce the space occupied by the passes and whereby air flow through the coil is directed through a tortuous path to produce a substantial turbulence in the air passage through the coil to improve the heat exchange characteristics of the coil.

Still another object of the present invention is to improve evaporator arrangements for association with air cooling domestic appliances by the provision of an economical three-piece construction including a continuously helically wound integral fin and tube member having return bend portions supportingly received by spaced apart members and joined together by parallel passes between the return bend portions that include a first plurality of passes located in a first common plane and a second plurality of passes located in a second common plane so as to define a central open region through the coil axially of the side members thereof.

A further object is to improve evaporator arrangements of the type set forth in the preceding object wherein the return bends of the integral tube and fin member have a plurality of fins on the outer radius thereof located in spaced apart relationship with one another and a second plurality of fins on the inner periphery thereof engaging one another to maintain a predetermined configuration in the return bends and wherein the tube passes are twisted between the return bends to offset integral fins thereon angularly with respect to the fins on the return bend portions.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

FIGURE 1 is a view in vertical section of a frost-proof refrigerator including an improved evaporator assembly constructed in accordance with the principles of the present invention;

FIGURE 2 is a view in end elevation of a coiled integral fin and tube member in the evaporator of FIGURE 1;

FIGURE 3 is a view in top elevation of another embodiment of the improved evaporator assembly;

FIGURE 4 is a view in elevation of one side of the assembly in FIGURE 3;

FIGURE 5 is a view in elevation of an opposite side of the assembly in FIGURE 3;

FIGURE 6 is a view in front elevation of the assembly in FIGURE 3;

FIGURE 7 is a view in top elevation of still another embodiment of the invention;

FIGURE 8 is a view in side elevation of the evaporator assembly in FIGURE 7; and

FIGURE 9 is a view in front elevation of the assembly in FIGURE 7.

Referring now to FIGURE 1, a representatively illustrated air cooling domestic appliance is shown including a frost-proof refrigerator 10 having an outer cabinet 12 and an inner liner 14 in between which is located a suitable thermal insulating material 16. In the illustrated arrangement the inner liner 14 is traversed by an insulated partition or divider wall 18 which forms in cooperation with the liner 14 a below-freezing compartment 20 and an above-freezing compartment 22. Each of the compartments has a front access opening thereto through the inner liner 14 which, in the case of the below-freezing compartment 20, is closed by a vertically hinged door closure member 24 and in the case of the above-freezing compartment 22 is closed by a vertically hinged door closure member 26.

In the illustrated arrangement the below-freezing compartment 20 has a bottom panel 28 therein which cooperates with the insulated partition 18 to form an evaporator compartment 30. The front of the evaporator compartment 30 is closed by a member 32 having a plurality of openings 34 therein serving as return openings for air flow from the below-freezing compartment 20 into the evaporator compartment 30. The insulated partition 22 also includes a plurality of openings 36 therein which communicate the above-freezing compartment 22 with the evaporator compartment 30 to serve as air flow return passageways from the compartment 22 into the compartment 30.

Rearwardly of the above and below-freezing compartments 20, 22 is located a shroud member 38 spaced from the rear wall of the inner panel 14 which combines with the panel 28 to form an inlet 40 from the evaporator compartment 30 into a centrifugal fan 42 driven by an electric motor 44 supported within an opening 46 within the insulating material 16 in the rear wall of the refrigerator.

The centrifugal fan 42 is selectively energized during the operation of the refrigerator 10 to draw air from the return openings 34, 36 into the evaporator compartment 30 and thence discharge a portion thereof through a passageway 48 between the shroud 38 and the rear wall of the inner liner 14 into the below-freezing compartment 20. The fan 42 also discharges air through a passageway 50 formed between a lower portion of the shroud 38 in the above-freezing compartment 22 for directing air into the compartment 22. A manually positionable damper member 52 is pivotally supported by a pin 54 in the lower part of the shroud 38 for proportioning air flow through the discharge passageways 48, 50 to maintain a desired temperature level in the compartments during a refrigerant cycle of operation of the refrigerator 10.

The above-described primary air circulation pattern is cooled as it passes through the evaporator enclosure 30 by an improved evaporator assembly 53 that, in accordance with certain principles of the present invention, is characterized by having a large number of evaporator coil passes and an unusually extended heat transfer surface thereon for producing a desired cooling of the air stream within a limited space within the air cooling appliance represented in the illustrated arrangement by the refrigerator 10. In the illustrated arrangement the evaporator assembly 53 includes a refrigerant accumulator 55 connected to the outlet piece thereof that, in turn, is connected by a conduit 56 to the suction side of a refrigerant compressor 58 that has its outlet connected by a conduit 60 to a condenser coil 62. The outlet of the condenser coil 62 communicates through a suitable refrigerant expansion means representatively shown as being an expansion valve 64 which is communicated by a conduit 66 in serial refrigerant flow relationship with the inlet pass of the evaporator assembly 53. The compressor 58 is cyclically operated by suitable control means during refrigerating cycles of

operation of the refrigerating unit 10 and is de-energized during a defrost cycle of operation.

In both frost-proof refrigerators, air conditioning units and like air cooling domestic appliances, there is a continual attempt to reduce the space occupied by an evaporator arrangement. For example, in frost-proof refrigerators of the illustrated type, it is desirable to continually reduce the size of the evaporator compartment so that it will take up as little as possible of the volume of associated above and below-freezing compartments. For example, in the illustrated arrangement, it is desirable to reduce the height of the evaporator assembly 53 as much as possible so that the panel 28 serving as the bottom of the below-freezing compartment 20 will be as much as possible in the same plane as the top of the insulated divider wall 18. Furthermore, by reducing the height of the evaporator arrangement 53, the illustrated downward bulge in the divider wall 18 can be minimized to reduce the amount of encroachment thereof into the food storage volume of the above-freezing compartment 22.

Similarly, though not illustrated, in many air conditioning units an attempt has been made to reduce the outer dimensional configurations of the unit so that they will extend, for example, in the case of both window air conditioning units and wall mounted air conditioning units, only to a slight degree into the room cooled by the units.

To accomplish a reduction in the dimensions of the evaporator arrangement 53, in the embodiment illustrated in FIGURES 2 through 5, a pair of spaced apart side members 68, 70 are supported by the insulated partition 18 on either side of the evaporator enclosure compartment 30 and a helically coiled integral fin and tube member 72 is arranged therebetween to occupy substantially the full height and width of the evaporator compartment 30. The member 72 includes a plurality of lower passes 74 located in a common plane adjacent the insulated partition 18 and a plurality of upper passes 76 located in close spaced relationship to the panel 28. Each of the upper and lower passes 74, 76 is joined by integral return bend portions 78 having a plurality of spaced apart outwardly directed integral fins 80 on the outer periphery thereof and a plurality of fins 82 on the inner periphery thereof that are collapsed into engagement with one another to serve as means for reinforcing the return bend portion 78 against being undesirably deformed so as to reduce or pinch off the refrigerant passageway therein. In the illustrated arrangement to reduce the height of the evaporator assembly 53, the return bends 78 can be inclined with respect to the end panels 68, 70 and directed through openings 84 therein to be supported by the panels 68, 70.

Between the side walls 68, 70, each of the passes 74, 76 has spaced-apart outwardly directed fins 86, 88, respectively, thereon directed into the interior of the helical coil 72 which have their ends spaced apart to define a central opening 90 through the evaporator assembly 53 for reasons more specifically set forth in the copending United States application Ser. No. 511,098, filed Dec. 2, 1965. Each of the passes 74, 76, respectively, also includes a plurality of outwardly directed spaced-apart integral fins 92, 94 that have their free ends located closely adjacent the panel 28 and partition 18 to further increase the heat transfer surface on the coiled member 72. The integral fin and tube helically coiled member 72 is especially suitable for association with an infrared heater assembly 96 that is selectively energizable to direct radiant energy against fins of the coil 72 so as to remove frost therefrom as more specifically set forth in the above-mentioned application.

Referring now to the embodiment in FIGURES 3 through 6, another version of an improved evaporator assembly 98 is set forth that includes spaced apart side wall members 100, 102 and a helically coiled integral fin and tube member 104. The helically coiled integral fin and tube member includes a plurality of passes 106 located

in a common plane adjacent the lower edge of the side members 100, 102 and located in a common plane immediately below the upper edge of the side members 100, 102. In this arrangement a first group 110 of the passes 106, 108 is formed between the side members 100, 102 and a second plurality of passes 106, 108 are located as a group 112 between members 100, 102 at a point spaced from the first group 110. This configuration is best seen in FIGURE 5. By virtue of this, an open space 114 is present between the side members 100, 102 through which is directed an infrared heater assembly 116 of the type more specifically set forth in the above-mentioned co-pending application. The heater assembly 116 has the ends thereof directed through openings 118, 120 in the side members 100, 102, respectively, for supportingly receiving the heating assembly 116 to locate it within the open space 114.

In the illustrated arrangement at the side member 102, the spaced apart passes 106, 108 are joined by return bend portions 122 formed integrally therewith. The return bend portions 122 are directed through spaced openings 124 in the side member 102 to be supportingly received thereby. In this arrangement the return bends 122 have no fins thereon and are bent through a predetermined radius and disposed vertically with respect to the side member 102. At the opposite side member 100, the passes 106, 108 are joined by integral return bend portions 126 that have a greater bend radius than do the return bend portions 122. The return bends 126 like return bend portions 122 have no fins thereon and are directed through openings 128 in the side member 100 to be supportingly received thereby. The openings 128 and return bend portions 126 are disposed at a predetermined inclination with respect to the side member 100 whereby the evaporator passes 106, 108 can be formed as a continuous helix in the evaporator assembly 98 and have a limited height as seen in FIGURES 5 and 7. The groups 110, 112 of passes 106, 108 are joined by an elongated return bend member 129.

In order to obtain a reduced height profile in the illustrated evaporator assembly in accordance with certain other of the principles of the present invention, the passes 106, 108 are twisted along their respective axes between the return bends 122 and 126 whereby a plurality of inwardly directed fins 130 on each of the passes 106 and a plurality of integral inwardly directed fins 132 on each of the passes 108 are turned inwardly of the coiled member 104 and the ends of fins 130, 132 are located in axial abutment, as best seen in FIGURES 5 and 7. Likewise, outwardly directed fins 134 on each of the passes 106 and outwardly directed fins 136 on each of the passes 108 are disposed at an inclination with respect to the horizontal to reduce the height of the assembly 98.

The inwardly directed fins 130, 132 are twisted on their axes with respect to the tube passes to produce a tortuous fluid flow path through the center of the evaporator assembly 98 that produces a substantial turbulence for improving the heat transfer efficiency of the evaporator assembly 98.

Referring now to the embodiment of the invention illustrated in FIGURES 7 through 9, another low-profile evaporator assembly configuration of an economical three-piece construction is illustrated that includes spaced apart side members 138, 140 and an integral fin and tube coiled member 142 that includes a plurality of passes 144 joined together by return bends 146 without fins that interconnect adjacent ones of the passes 144 located in a common plane adjacent the lower edge of the side members 138, 140 to form a sinusoidal pattern between the end plates 138, 140. Each of the lower passes 144 includes a plurality of outwardly directed integral fins 148 between the side members 138, 140 and a like plurality of inwardly directed fins 150. The lower passes 144 are joined by a return bend 152 to a plurality of passes 154 between the side members 138, 140 located in a common plane immediately below the upper edge of the side members

138, 140 in spaced relationship to the lower passes 144. Each of the upper passes 154 has its opposite ends joined by integral return bends 156 to form a sinusoidal pattern in the evaporator assembly 142 like that formed by the passes 144. Each of the passes 154 includes a plurality of outwardly directed fins 158 and a plurality of inwardly directed fins 160.

As was the case in the second embodiment, to reduce the height of the evaporator assembly 142, each of the passes 144, 154 between the return bends 146, 156 is twisted along its axis with respect to the return bends so as to cause the inwardly directed fins 150, 160 thereon to have the ends thereof located in abutting relationship with one another to reduce the height of the two sinusoidal patterns between the side members 138, 140.

In the illustrated arrangement the finless return bends 146, 156 are directed through spaced apart openings 162 in each of the side members 138, 140 to support the coiled integral fin and tube member 142 therebetween. In this embodiment of the invention, the reduced height advantages are present and, furthermore, the inwardly directed fins 150, 160 create a tortuous fluid flow path through the evaporator assembly to improve the heat exchange efficiency thereof.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

In the claims:

1. A three-piece extended surface heat exchanger unit including first and second end wall members, means forming a plurality of spaced apart elongated openings in each of said side wall portions, a continuously coiled tube member having a first plurality of passes located in a common first plane through an upper part of each of said side member portions, a second plurality of passes located in a second common plane spaced apart from said first common plane, a plurality of fins on each of said passes located at spaced apart points therealong and directed outwardly of said passes, return bend portions integrally formed with said passes, said return bend portions being supported by said side members within said spaced apart openings therein for supporting said passes in said common planes and in spaced apart relationship to one another, said return bends each having a plurality of spaced apart integral fins on the outer periphery thereof and a plurality of fins on the inner periphery thereof in engagement with one another to maintain a predetermined inner radius on each of said return bend portions.

2. A three-piece extended surface heat exchanger unit including first and second end wall members, means forming a plurality of spaced apart elongated openings in each of said side wall portions, a continuously coiled tube member having a first plurality of passes located in a common first plane through an upper part of each of said side member portions, a second plurality of passes located in a second common plane spaced apart from said first common plane, a plurality of fins on each of said passes located at spaced apart points therealong and directed outwardly of said passes between said first and second planes, return bend portions integrally formed with said passes, said return bend portions being supported by said side members within said spaced apart openings therein for supporting said passes in said common planes and in spaced apart relationship to one another, each of said tube member passes being angularly twisted along their longitudinal axes from said return bend portions whereby adjacent fins on said first and second plurality of passes are located in intersecting relationship with one another to increase fluid flow turbulence as air passes parallel to and between said first and second plurality of passes in the vicinity of said fins.

3. A three-piece extended surface heat exchanger unit including first and second end wall members, means forming a plurality of spaced apart elongated openings in

each of said side wall portions, a continuously coiled tube member having a first plurality of passes located in a common first plane through an upper part of each of said side member portions, a second plurality of passes located in a second common plane spaced apart from said first common plane, a plurality of fins on each of said passes located at spaced apart points therealong and directed outwardly of said passes between said first and second planes, return bend portions integrally formed with said passes, said return bend portions being supported by said side members within said spaced apart openings therein for supporting said passes in said common planes and in spaced apart relationship to one another, each of said tube member passes being angularly twisted along their longitudinal axes from said return bend portions whereby adjacent fins on said first and second plurality of passes are located in intersecting relationship with one another to increase fluid flow turbulence as air passes through said first and second plurality of passes in the vicinity of said fins, said return bend portions each connecting one end of one of the passes in said first plurality of passes and one end of one of the passes in said second plurality of said second passes whereby said return bends and said passes form a continuous helical path between said side members.

4. A three-piece extended surface heat exchanger unit including first and second end wall members, means forming a plurality of spaced apart elongated openings in each of said side wall portions, a continuously coiled tube member having a first plurality of passes located in a common first plane through an upper part of each of said side member portions, a second plurality of passes located in a second common plane spaced apart from said first common plane, a plurality of fins on each of said passes located at spaced apart points therealong and directed outwardly of said passes, return bend portions integrally formed with said passes, said return bend portions being supported by said side members within said spaced apart openings therein for supporting said passes in said common planes and in spaced apart relationship to one another, said first and second plurality of passes each having a plurality of spaced apart integral fins thereon inwardly directed between said first and second common planes of said tube member passes, each of said inwardly directed fins having the ends thereof located in abutting relationship, said return bends each having a plurality of spaced apart integral fins on the outer periphery thereof and a plurality of spaced apart integral fins on the inner periphery thereof in engagement with one another to maintain a predetermined inner radius on each of said return bend portions.

5. A three-piece extended surface heat exchanger unit including first and second end wall members, means forming a plurality of spaced apart elongated openings in each of said side wall portions, a continuously coiled tube member having a first plurality of passes located in a common first plane through an upper part of each of said side member portions, a second plurality of passes located in a second common plane spaced apart from said first common plane, a plurality of fins on each of said passes located at spaced apart points therealong and directed outwardly of said passes, return bend portions integrally formed with said passes, said return bend portions being supported by said side members within said spaced apart openings therein for supporting said passes in said common planes and in spaced apart relationship to one another, said first and second plurality of passes each having a plurality of spaced apart integral fins thereon in-

wardly directed between said first and second common planes of said tube member passes, each of said inwardly directed fins having the ends thereof located in abutting relationship, said return bends each having a plurality of spaced apart integral fins on the outer periphery thereof and a plurality of fins on the inner periphery thereof in engagement with one another to maintain a predetermined inner radius on each of said return bend portions, each of said tube member passes being angularly twisted along their longitudinal axes between said return bend portions whereby adjacent fins on said first and second plurality of passes are located in intersecting relationship with one another to increase fluid flow turbulence as air passes parallel to and between said first and second plurality of passes in the vicinity of said fins, said fins on said passes being angularly offset with respect to fins on said return bend portions.

6. A three-piece extended surface heat exchanger unit including first and second end wall members, means forming a plurality of spaced apart elongated openings in each of said side wall portions, a continuously coiled tube member having a first plurality of passes located in a common first plane through an upper part of each of said side member portions, a second plurality of passes located in a second common plane spaced apart from said first common plane, a plurality of fins on each of said passes located at spaced apart points therealong and directed outwardly of said passes, return bend portions integrally formed with said passes, said return bend portions being supported by said side members within said spaced apart openings therein for supporting said passes in said common planes and in spaced apart relationship to one another, said first and second plurality of passes each having a plurality of integral fins thereon inwardly directed between said first and second common planes of said tube member passes, each of said inwardly directed fins having the ends thereof located in abutting relationship, said return bends each having a plurality of spaced apart integral fins on the outer periphery thereof and a plurality of fins on the inner periphery thereof in engagement with one another to maintain a predetermined inner radius on each of said return bend portions, said return bend portions each connecting one end of one of the passes in said first plurality of passes and one end of one of the passes in said second plurality of said second passes whereby said return bends and said passes form a continuous helical path between said side members.

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