May 3, 1960 W. A. COLLINS 2,934,917

EVAPORATOR

Filed Feb. 27, 1956 3 Sheets-Sheet 1

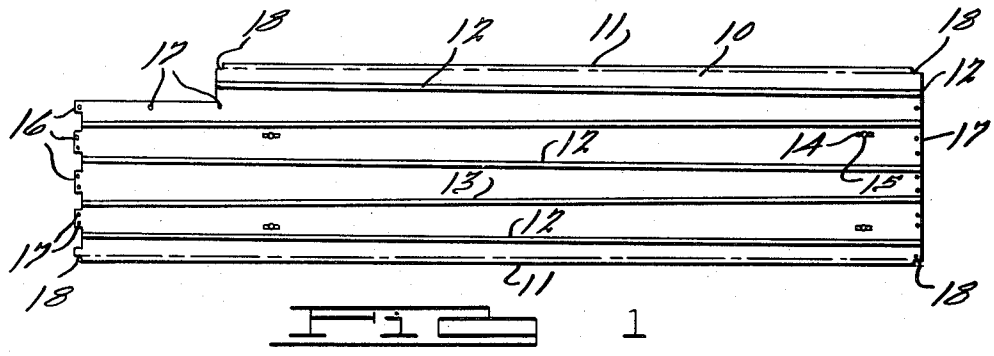

Fig. 1

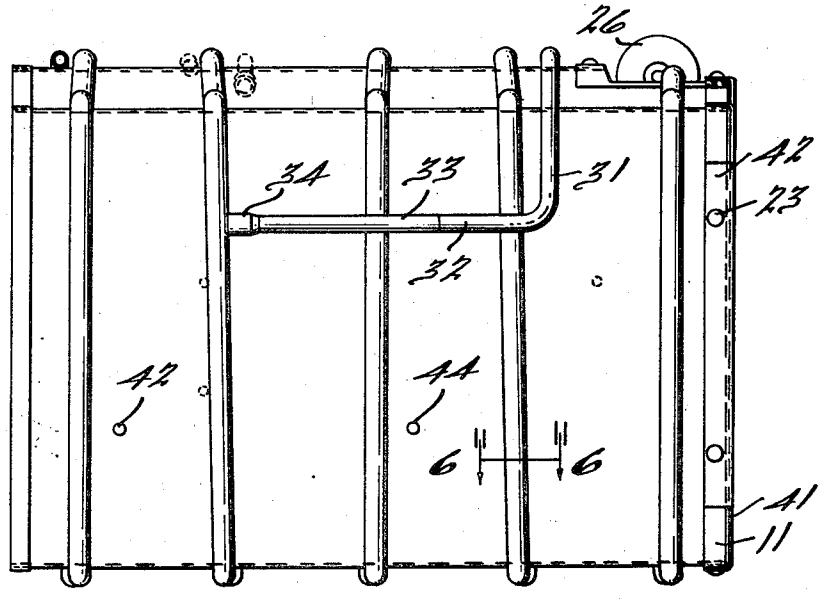

Fig. 2

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Filed Feb. 27, 1956 3 Sheets-Sheet 2

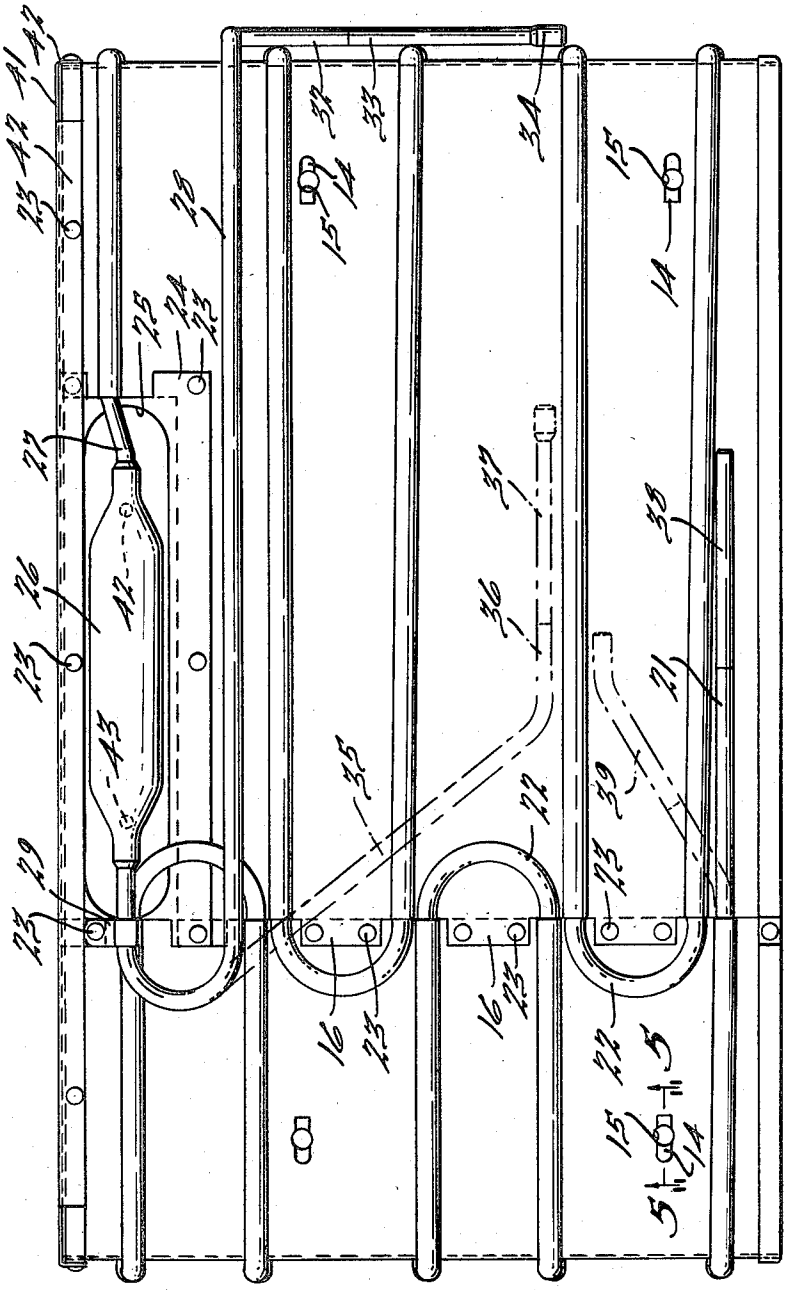

FIG. 3

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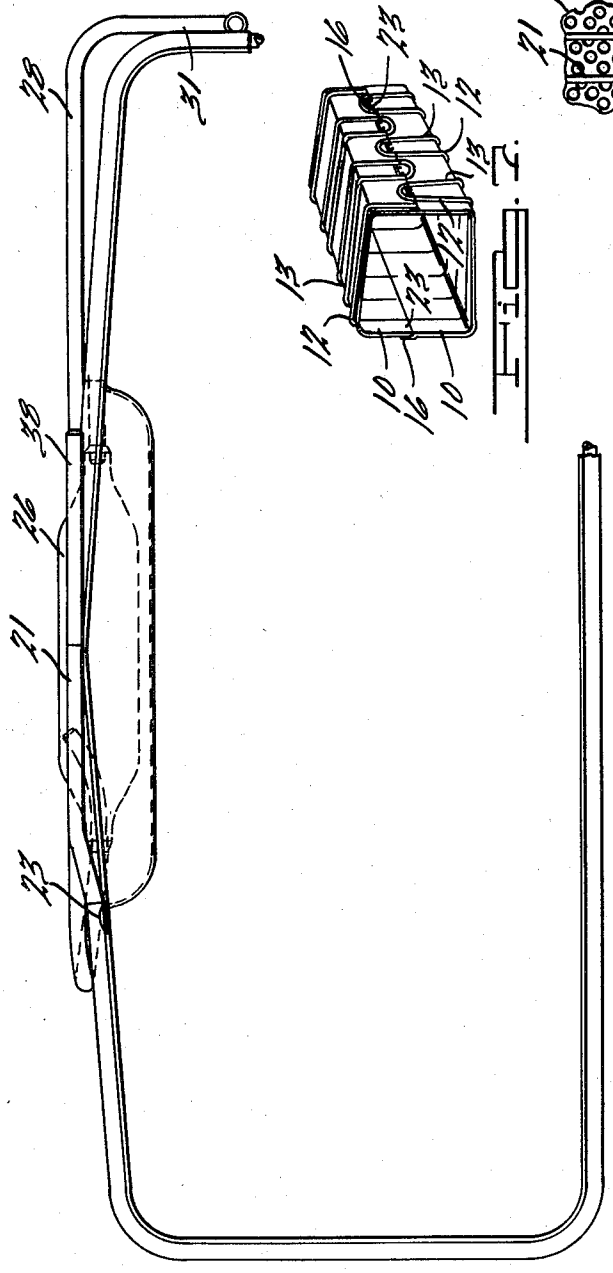

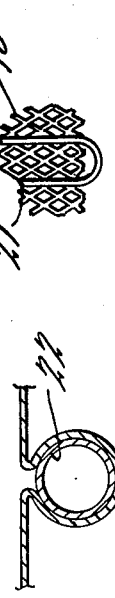

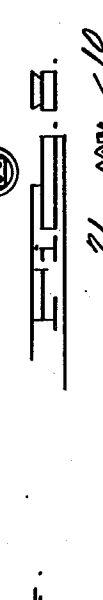

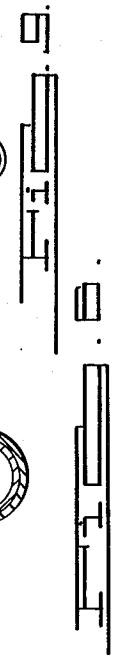







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2,934,917

EVAPORATOR

William A. Collins, Dowagiac, Mich., assignor to Rudy Manufacturing Company, Dowagiac, Mich., a corporation of Michigan

Application February 27, 1956, Serial No. 567,955

10 Claims. (Cl. 62—516)

This invention relates to heat exchangers, and particularly to a heat exchanger employed as an evaporator for a refrigerant.

The present invention pertains to an evaporator made from a length of sheet material, preferably of aluminum which is formed throughout its length with channels in alternate converging and diverging relationship for supporting a serpentine shaped conduit for the refrigerant. The aluminum sheet is preferably of the stucco or other type which provides strength while permitting thinner sheets to be employed. The conduit is formed sinuously to have elongated sections thereof which nest within the channels of the sheet, with the loops at the ends projecting beyond the ends of the sheet. The channels of the sheet are further formed thereafter to have the material thereof wrapped around the straight sections of the conduit to secure them rigidly in position with the metal of the sheet between the channels disposed in a smooth plane. The sheet is then formed into rectangular shape, with the loops of the ends overlapping the opposite ends of the sheet. One end of the sheet has extended tabs which lap over the opposite end of the sheet and are secured thereto by welding, riveting or the like.

Four apertures are formed in the sheet near the ends which form the top part of the rectangular evaporator by which the evaporator is supported to a shelf or the top wall of the recess within the refrigerator. The top and bottom of the evaporator may be in parallel relation or the top may slope from the center, a side or front end and when in this relationship the metal about the apertures by which the evaporator is supported is embossed to be in a horizontal plane. A recess is cut in one corner of the sheet which is filled by a formed sheet to have recess therein for receiving an accumulator which is connected at one end to the conduit, the other end having a length of tubing connected thereto by which connection is made to the refrigeration system. The opposite end of the conduit is disposed in position to be connected into the system and when the conduit is made of steel or aluminum, a length of conduit on the ends is preferably made of copper which is brazed, welded or otherwise secured thereto to permit the ready brazing of copper tubing to the ends of the conduit of the evaporator. In some applications a panel may be applied to the rear face of the sheet to enclose the evaporator on all sides except the front. By having the channel portions of the sheet and the conduit lengths disposed therein in alternate diverging and converging relationship, the loop at the converging ends will nest between the opposite or diverging ends and in this manner the tubes forming the conduit for the evaporator nest with each other to have the entire area affected by the refrigerant.

Accordingly, the main objects of the invention are: to construct an evaporator from a sheet of material having alternate converging and diverging straight lengths of a sinuously formed conduit thereon, with the end loops located at the converging ends nested between the opposite diverging ends when the sheet is formed into a closed figure forming the evaporator; to form channels in a sheet of material lengthwise thereof in a manner to have alternate channels diverging and converging at opposite ends so that conduits supported in the channels will have their loops at the converging ends nest between the conduits at the diverging ends when the sheet is formed into a closed figure with the ends overlapping; to secure the straight portions of a sinuously formed tube in alternate diverging and converging relation on a sheet with the looped portions at the converging ends extending therebeyond to nest in the opposite diverging ends when the sheet is bent into a closed figure the desired shape for the evaporator; to form an evaporator with a top which slopes downwardly in which apertures are provided in embossed areas located in a horizontal plane, and, in general, to provide an evaporator which is simple in construction and economical of manufacture.

Other objects and features of novelty of the invention will be specifically pointed out or will become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a plan view of a sheet employed in the construction of an evaporator of the present invention;

Fig. 2 is an enlarged view in side elevation of an evaporator constructed from the sheet illustrated in Fig. 1;

Fig. 3 is an enlarged plan view of the evaporator illustrated in Fig. 2;

Fig. 4 is a front view of the evaporator illustrated in Fig. 3;

Fig. 5 is an enlarged sectional view of the structure illustrated in Fig. 3, taken on the line 5—5 thereof;

Fig. 6 is an enlarged sectional view of the structure illustrated in Fig. 2, taken on the line 6—6 thereof;

Fig. 7 is a reduced perspective view of an evaporator showing another form thereof;

Fig. 8 is a broken view of an evaporator showing a further form thereof, and

Fig. 9 is a view of structure similar to that illustrated in Fig. 8 showing still another form of the invention.

It was found, when constructing evaporators or large productions, that the tool cost could readily be absorbed, but when limited quantities of evaporators were constructed a similar tool cost would be prohibitive. As a result, it was difficult for the manufacturer of small quantities of refrigerators to compete with the large manufacturers because of the inability to employ high cost tooling.

The present invention has solved this problem by employing a method of construction in which a standard line of tools can be employed from which evaporators of various dimensions may be readily constructed. An elongated sheet of material 10 is employed, having a rolled-over edge 11 at each side and channels 12 and 13 formed therein throughout the length of the sheet. The channels 12 are disposed parallel to each other and at an angle to the edge of the sheet. The channels 13 are also parallel to each other and at an angle to the edge of the sheet and to the channels 12. In this manner, opposite ends of pairs of the channels will be reversed, diverging at one end and converging at the other. Embossed areas 14, having apertures 15 therein, are also formed in the sheet adjacent to the opposite ends. One corner is cut from the sheet and tabs 16 are provided on one end, having apertures 17 therein which mate with apertures 17 on the opposite end of the sheet. The doubled-over edge 11 is cut away at 18 at each end so as to provide only two layers of metal when the ends of the sheet are in overlapping relation. The sheet may be made of steel, copper or aluminum, but a stucco or otherwise strengthened aluminum sheet was found to be most

adaptable, being readily bent and formed into the shape of the evaporator.

A conduit 21, which is also preferably made of aluminum, although steel, copper or other material may be employed, is bent into serpentine form, with the same size loops 22 at each end. The straight lengths between the loops are substantially equal to the lengths of the channels 12 and 13. After the tube is formed in this manner, the straight lengths are placed within the channels 12 and 13, with the loops extending beyond the ends of the sheet, and the metal of the channel is formed around the tube, as illustrated in Fig. 6. This may be accomplished by any well-known method preferably by that illustrated in the copending application of Thomas H. Polad, Serial No. 215,822, filed March 15, 1951, for Tube Enveloping Plate Condenser Having Rolled Ends and Method of Its Construction which has matured into Patent No. 2,772,077, granted November 27, 1956. After the lengths of the tube are retained in place in this manner, the sheet is formed into rectangular or other shape, such as that illustrated in Fig. 4, to provide a closed figure the shape of the evaporator desired. The tabs 16 will overlap the opposite end of the sheet, and rivets 23 extending through the apertures 17 secure the ends together to complete the walls of the evaporator.

As is evident from Fig. 4, the inner walls of the evaporator will be of smooth construction as the conduits and the metal of the channel wrapped therearound will be on the outer surface thereof. The loops 22 being at the converging ends of a pair of channels 12 and 13 will nest between the opposite diverging ends thereof to have the loop extending from one end of the sheet overlap the opposite end of the sheet. With this construction the refrigerant is supplied to all areas of the sheet when formed into the evaporator.

A separate formed sheet 24 fills in the cutaway corner of the sheet, having a central recessed portion 25 for receiving an accumulator 26 to which one end 27 of the conduit 21 is attached. The opposite end of the accumulator has a conduit 28 attached thereto and secured in position by a clip 29 which is riveted to the lapped-over ends of the sheets. The conduit 28 extends along the top of the evaporator downwardly at 31 at one side and then laterally at 32. When made of steel or aluminum a section of copper tubing 33 is brazed, butt-welded or otherwise secured to the end 32 to provide an expanded end 34 to which the end of the conduit of the refrigeration system is readily connected. As illustrated in dot and dash line, the conduit 28 may extend laterally across the top at 35 and then parallel to a section of the conduit 21 at 36, with the length of copper tubing 37 secured thereto.

The opposite end of the conduit 21 may have a length of copper tubing 38 brazed, welded or otherwise secured thereto for connection into a refrigeration system. This end may be bent laterally, as shown in dot and dash line, with the end section of copper tubing 39 secured thereto. The sections of copper tubing 37 and 39 are disposed closely adjacent each other at the top center of the evaporator.

When it is desired to close the rear face of the evaporator, a back panel 41 is provided the shape of the opening through the evaporator, having flanges 42 at the edges which extend over the reversely bent edge 11 at the rear of the evaporator and secured thereto by rivets 23. The plate 24 is secured to the sheet 10 by similar rivets 23 and apertures 43 are provided in the bottom of the recess portion 25 for draining the moisture which may collect therein. Apertures 44 may be provided in the side walls of the evaporator for supporting a shelf between the two side walls in the conventional manner.

It is to be understood that two sheets 10 may be employed, formed into U-shape, and a pair of the U-shaped sheets joined by their overlapped extending ends are secured together as by riveting in the manner herein illustrated. Such an arrangement is illustrated in Fig. 7 wherein the adjacent loops overlap adjacent sheets in nested relation to the straight lengths to form an evaporator having all the area thereof in contact with the conduit. Such an arrangement may be desired when a large evaporator is to be constructed from tools limited in length to form evaporators of smaller size.

As pointed out above, the top of the evaporator may be parallel to the bottom but is preferably in sloping relation thereto to permit the water to run therefrom when the evaporator is defrosted. In Fig. 4 the top of the evaporator is shown sloping from one side edge to another and may be arranged to slope from the front to the back. The sheet material may be of the expanded type or may be perforated as illustrated in Figs. 9 and 8. When employed, the serpentine tube is preferably brazed or welded directly thereto, depending on whether the material is steel, aluminum, copper or the like. Such a tube would have straight lengths in diverging and converging relationship to have the end loops nested when the ends of the sheet are secured together. Before and after assembly the evaporator is suitably finished; if of aluminum, being suitably treated, baked, dipped in clear paint material and baked; if of steel, hot dipped, galvanized or zinc plated, Bonderized and finished in several coats of paint.

What is claimed is:

1. An evaporator made from an elongated sheet of material which is bent transversely at four points to have the adjacent ends in abutting relation and forming an evaporator frame, a conduit formed into serpentine shape having straight portions the length of the sheet joined by looped ends, with the straight portions secured to the sheet when disposed in diverging relationship so as to permit the loop on the opposite ends of two straight portions to nest therebetween when the ends of the sheet are secured together.

2. An vaporator made from sheet material bent into rectangular form, a conduit of sinuous shape secured to said material, the conduit having straight lengths with loops at the ends thereof and with adjacent loops overlapping one another and disposed between the opposite diverging ends of the straight lengths extending from the loop when in secured position on the material.

3. The method of forming an evaporator which includes the steps of: forming channels throughout the length of an elongated sheet of material with alternate channels parallel to each other and at an angle to the adjacent channels so that each adjacent pair will converge at one end and diverge at the opposite end, forming a tube into sinuous form having straight lengths joined by loops, the straight length portion being substantially the length of the channels, securing the straight lengths within the channels to have the loops extend beyond the end, and forming the sheet into a closed figure and joining the ends thereof with the loops nested between the opposite diverging ends of the straight portions in extension thereof, said sheet having the ends joined at the top portion of the resulting closed figure.

4. The method of forming an evaporator which includes the steps of: forming channels throughout the length of an elongated sheet of material with alternate channels parallel to each other and at an angle to the adjacent channels so that each adjacent pair will converge at one end and diverge at the opposite end, forming a tube into sinuous form having straight lengths joined by loops, the straight length portion being substantially the length of the channels, securing the straight lengths within the channels to have the loops extend beyond the end, forming the sheet into a closed figure and joining the ends thereof with the loops nested between the opposite diverging ends of the straight portions in extension thereof, said sheet having the ends joined at the top portion of the resulting closed figure, and providing at least four

apertures in the sheet by which the evaporator is supported.

5. The method of forming an evaporator which includes the steps of: forming channels throughout the length of an elongated sheet of material with alternate channels parallel to each other and at an angle to the adjacent channels so that each adjacent pair will converge at one end and diverge at the opposite end, forming a tube into sinuous form having straight lengths joined by loops, the straight length portion being substantially the length of the channels, securing the straight lengths within the channels to have the loops extend beyond the end, forming the sheet into a closed figure and joining the ends thereof with the loops nested between the opposite diverging ends of the straight portions in extension thereof, said sheet having the ends joined at the top portion of the resulting closed figure, said joining of the sheets occurring at the center of the top portion of the closed figure from which the sheet slopes downwardly toward the sides, and providing at least four embossed areas near the corners of the top portion having apertures therethrough located in a horizontal plane.

6. In an evaporator, an elongated sheet of material, a sinuously formed tube having straight portions joined by loops, means for securing said straight portions to the sheet to have opposite ends of adjacent pairs of the tube diverging and converging, and means for securing the two ends of the sheet together when formed into an evaporator, with the loops extending from one end of the sheet nesting between the loops extending from the other end of the sheet.

7. In an evaporator, an elongated sheet of material, a sinuously formed tube having straight portions joined by loops, means for securing said straight portions to the sheet to have opposite ends of adjacent pairs of the tube diverging and converging, and means for securing the two ends of the sheet together when formed into an evaporator, with the loops extending from one end nesting between the straight portions of the tubes which extend from the loops with the loops projecting over the opposite end of the sheet, said sheet having rows of apertures therethrough.

8. In an evaporator, an elongated sheet of material, a sinuously formed tube having straight portions joined by loops, means for securing said straight portions to the sheet to have opposite ends of adjacent pairs of the tube diverging and converging, and means for securing the two ends of the sheet together when formed into an evaporator, with the loops extending from one end nesting between the straight portions of the tubes which extend from the loops with the loops projecting over the opposite end of the sheet, said sheet being of the expanded metal type.

9. In an evaporator, an elongated sheet of material, a sinuously formed tube having straight portions joined by loops, means for securing said straight portions to the sheet to have opposite ends of adjacent pairs of the tube diverging and converging, and means for securing the two ends of the sheet together when formed into an evaporator, with the loops extending from one end nesting between the loops extending from the other end of the sheet, the top of said evaporator sloping toward at least one side edge thereof.

10. In an evaporator, a pair of elongated sheets bent in U-shape, a sinuously formed tube having straight portions joined by loops, means for securing said straight portions to the sheets to have opposite ends of adjacent pairs of the tube diverging and converging, and means for securing the pairs of U-shaped sheets together to form an evaporator, with the loops extending from one end nesting between the straight portions of the tubes which extend from the loops with the loops projecting over the opposite end of the sheet.

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