Jan. 12, 1960 A. G. JANOS 2,920,377

EVAPORATOR STRUCTURE AND METHOD OF MANUFACTURE

Filed Oct. 12, 1956

FIG. 1

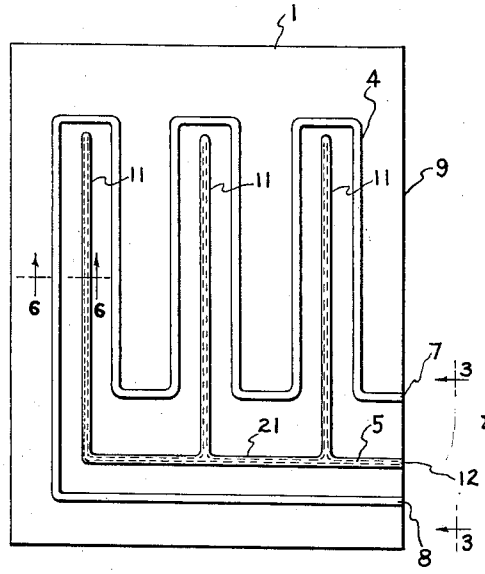


FIG. 2

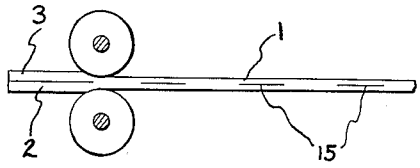


FIG. 3

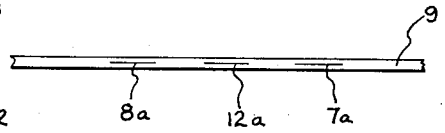


FIG. 4

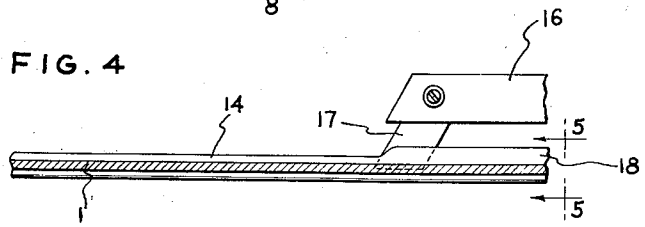


FIG. 5

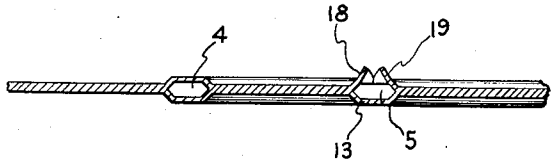
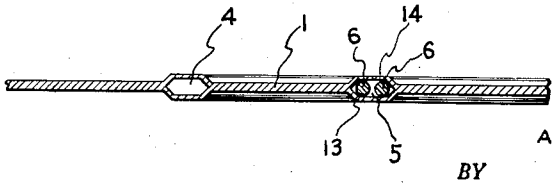


FIG. 6



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EVAPORATOR STRUCTURE AND METHOD OF MANUFACTURE

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2 Claims. (Cl. 29—155.5)

The present invention relates to evaporator structures of the roll-bonded type and more particularly to the method of manufacturing such a structure.

Various methods and means have heretofore been provided to eliminate the coating of frost that accumulates on an evaporator which is being used to remove heat from a surrounding, relatively warmer atmosphere, such as is illustrated by the evaporator of a refrigerator. Many previous attempts to solve this problem have utilized a heater that is positioned closely adjacent the evaporator structure for periodically heating the structure to melt the accumulated frost and ice. In evaporators of the roll-bonded type, it has been the practice to clamp a heating wire to the surface of the sheet, making several passes of the wire along the sheet to provide the necessary heat transfer. In the above type of apparatus, heat transfer is very poor between the heating wire and the roll-bonded sheet because the heat is transferred to the sheet by direct contact with the heating wire at only one point on the circumference of the wire. The remaining heat, transferred by convection currents, is very poor. The heat transfer can sometimes be improved by the provision of a masking material around the outer portions of the wire for preventing the escape of heat in directions away from the evaporator structure. Another disadvantage of the above type of defrosting arrangement is that the heating wire is in an unprotected position adjacent the evaporator and can be easily damaged.

It is an object of the present invention to provide a method of manufacturing an improved evaporator structure having a heater wire positioned therein, and forming an integral part thereof.

Further objects and advantages of the invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In carrying out the objects of this invention there is provided an evaporator structure in the form of a roll-bonded sheet of metal having a pair of separate passages formed therein. One of the passages is provided for conducting a refrigerant for heat transfer purposes. A heater wire which is completely enclosed within the second passage and connected to a means for supplying an electrical current thereto is provided for periodic defrosting of the heat exchange structure. The heat exchange structure is formed by roll-bonding into a single sheet, two sheets of metal having between them a stop-weld material arranged in two separate paths. By applying a fluid under pressure to the areas which were prevented from forging by the stop-weld material, the non-forged portions are expanded to form two separate passages within the sheet. After slitting one of the passages lengthwise along its expanded portion and bending outwardly the tabs formed thereby, a heater wire is inserted into the passage. By bending the tabs back into

place, the heater wire is clamped into position within the heat exchange structure.

For a better understanding of the present invention reference may be had to the accompanying drawings in which:

Fig. 1 is a plan view of an evaporator structure incorporating the present invention;

Fig. 2 is an elevation view illustrating the roll-bonding of two sheets into one by hot rolling;

Fig. 3 is edge view of a sheet of roll-bonded metal taken along line 3—3 of Fig. 1;

Fig. 4 is a cross sectional view of a roll-bonded sheet having an expanded passage and a slitting mechanism;

Fig. 5 is a cross sectional view taken along line 4—4 of Fig. 3; and

Fig. 6 is a cross sectional view similar to Fig. 5 taken along the line 6—6 of Fig. 1.

Referring now to Fig. 1 there is shown an evaporator structure incorporating the defrost arrangement of the present invention. The evaporator comprises a sheet 1 of thermally conducting material, such as an alloy of copper or aluminum. The single sheet 1 has been formed from a pair of identical sheets 2 and 3 by a roll-bonding or roll-forging process well known in the art, as illustrated in Fig. 2. The sheet 1 is provided with a pair of continuous passages, integrally formed therein. Thus, as can be seen in Fig. 1, the sheet 1 is provided with a passage or refrigerant conduit 4 for carrying a suitable refrigerant and a second passage or heater conduit 5 into which a heater wire 6 is inserted. The refrigerant passage 4 forms a serpentine configuration upon the sheet 1 and is provided with openings 7 and 8 at one edge 9 of the sheet. It is obvious that the refrigerant passage can take on any desired configuration so long as there are two openings somewhere on the thermally conducting sheet 1. It is contemplated that during the operation of the heat exchanger the openings 7 and 8 will be connected in refrigerant flow relationship with a suitable compressor (not shown) and condenser (not shown).

The heater passage 5 is provided with a plurality of fingers 11 extending adjacent to and between the convolutions formed by the refrigerant passage 4. The specific configuration of the heater passage will be dependent upon the configuration of the refrigerant passage, but it is desirable for defrost purposes that the heater passage lie adjacent to as much of the refrigerant passage as possible. As can be seen in Fig. 1, the heater passage has an opening 12 in the edge 9 of the sheet of thermal conductive material. As illustrated by the dotted line positions shown in Fig. 1, the heater wire 6 forms a completed circuit within the heater passage 5, entering at the edge of the sheet 9 through the opening 12 and also exiting at this point. Thus, referring to Fig. 6, a double strand of heater wire 6 is provided throughout the heater passage 5.

In operation the heater wire 6 will be connected in series with a means for applying an electrical current thereto at those times when defrosting of the refrigerant carrying passage is found necessary. As can best be seen in Fig. 6 the arrangement of the heater wire 6 within the passage 5 provides a very efficient heat transfer arrangement between the wire 6 and the heat exchange structure 1. When an electrical current is passed through the wire 6 and heat is generated thereby, the only possible means for transferring the heat away from the wire 6 is through the walls 13 and 14 which completely surround the wire 6. Heat is then transferred by direct conduction along the sheet 1 to the various portions of the refrigerant passage 4. With this arrangement it is possible to reduce the defrost time to a minimum with a minimum loss of power due to heat dissipation.

In order to manufacture or form the above described evaporator, a pair of sheets 2 and 3 of thermal conducting material are provided for the roll-forging or roll-bonding process. A stop-weld or weld-preventing material 15 of a type well known in the art, such as a mixture or graphite in water glass, is then applied in a thin layer to selected areas on the face of one of the sheets according to a predetermined pattern. Such weld-preventing material may be sprayed through a masking die, or painted through a stencil, or applied in any other suitable manner. The pattern for applying the weld-preventing material may be of almost any desired configuration so long as it comprises a pair of separate paths which do not come into contact at any portion of their configuration. One of the paths must be exposed on at least two points around the edge of the sheet. This path will later be expanded to form the refrigerant carrying passage 4. The other path must be exposed on at least one point around the edge of the sheet and will later be expanded to form the heater carrying passage 5.

After the pattern of weld-preventing material 15 has been applied to one of the sheets, the sheet 3 is placed on sheet 2 with the weld-preventing material 15 between them. This assembly is then roll-bonded or roll-forged by means well known in the art, as illustrated in Fig. 2, to form the single sheet 1. In order to roll-forge the assembly, the sheets 2 and 3 are first fastened together to avoid obliteration of the pattern. This may be done by any suitable means, such as heating or welding the edges, tacking the edges together by spot welding, or crimping the edges, or the like. The assembly is then placed in a furnace and heated to a temperature sufficiently high to effect pressure welding of the two sheets of metal in the hot-rolling step illustrated in Fig. 2. The exact temperature to be used for pressure welding is, of course, dependent upon the melting point of the particular metal or alloy utilized and should be relatively close thereto. After the hot-rolling step described above, it is sometimes necessary to cold-roll the sheet in order to accurately control the thinness of the sheet. If this is the case it is sometimes necessary to anneal the finished sheet to reduce the stresses set up during the cold-rolling process.

During the rolling process, the portions of the sheets 2 and 3 adjacent the pattern or area covered by the weld-preventing material are prevented from forging together into a single sheet. After the rolling and other such processing has been completed, the unbonded portions are then expanded by applying a fluid pressure. This is accomplished by mechanically prying open the unbonded portions formed at points 7^a, 8^a and 12^a in the edge 9 of the sheet 1, as can be seen in Fig. 3. A very high fluid pressure is applied, through use of a plurality of tubes of copper or other suitable tubular material (not shown) connected at one end to a source of very high fluid pressure and having the other end or ends inserted into the openings at points 7^a, 8^a and 12^a and brazed or threaded therein. As will be understood by those familiar with the art, the amount of fluid pressure necessary will vary with the gage, temper, and composition of the metal used but sufficient pressure is applied to expand the metal in the unwelded or unbonded inner portions adjacent the weld-preventing material. Upon application of the desired fluid pressure the refrigerant and heater carrying passages 4 and 5 respectively, are formed.

In order to insert the aforementioned heater wire 6 into the heater carrying passage or conduit 5 formed by applying pressure to the roll-bonded sheet 1, it is necessary to slit one of the expanded walls 14 of the passage lengthwise along the length of the passage. This is performed by a cutting arm 16 carrying a cutting tool 17 which is inserted into the heater passage 5 at the end thereof and traversed the length of the passage. Thus, as can be seen in Fig. 4, the cutting tool 17, inserted into the passage 5 and traversed the length thereof, slits the upper

wall 14 of the heater passage, dividing the wall 14 into tabs 18 and 19 on either side of the slit. The tabs 18 and 19 are shown in Fig. 5. It is necessary to turn the tabs 18 and 19 outwardly in order to provide an opening through which the heater wire 6 may be inserted. By the proper design of the cutting tool 17, it is possible to turn the tabs 18 and 19 outwardly during the slitting operation. This may be performed, however, as a separate operation by passing a properly designed tool along the slit formed in the wall 14 of the heater passage. In order to slit the entire length of the heater passage and thereafter turn the tabs outwardly, it might be necessary according to the particular configuration of the heater passage, to make several cutting and turning passes with the cutting and turning tools. Thus, for the configuration shown in Fig. 1 it would be necessary to make four passes for each operation, one for each of the upwardly extending fingers 11 and one along the base portion 21 of the heater passage.

After the tabs 18 and 19 have been turned outwardly from the heater passage 5, the next step is to insert the heater wire 6 within the passage. As shown in the illustrated embodiment of the invention, the heater wire forms a continuous loop through the heater passage 5 and provides a completed electrical circuit therein. This particular arrangement for the heater wire is not considered absolutely essential to the invention, and it could take on many forms depending on the configuration of the heater passage, such as a single wire extending the length of a continuous passage having two openings somewhere around the edge 9 of the sheet 1.

After the heater wire 6 has been inserted, the tabs 18 and 19 are bent back into their original position thereby retaining the heater wire in place within the passage 5. This operation may be accomplished in any of a number of different ways such as by rolling, stamping, pressing or the like as long as the heater wire 6, positioned within the passage, is not damaged.

By the present invention there has been provided a method of manufacturing an evaporator structure having a heater wire, defrosting means arranged to promote heat transfer of maximum efficiency between the wire and the heat exchange structure. Furthermore the method outlined above provides a simple, low-cost process for manufacturing the above-described evaporator.

While in accordance with the patent statutes there has been described what at present is considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, the aim of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a method of forming an evaporator having defrost means, the steps comprising superimposing one upon the other two sheets of metal having a stop-weld material arranged therebetween in at least two separate and continuous paths, said paths each being exposed on an edge of the sheets, roll-bonding said two sheets into one by rolling said sheets at a temperature sufficiently high to cause said sheets to completely forge together into one except where said stop-weld material has been arranged, applying a high fluid pressure to separate said non-forged portions of said sheet to form a pair of continuous passages, slitting one of said passages lengthwise along the length of said passage thereby forming tab portions adjacent said slit, turning said tab portions of said slit passage outwardly, inserting a heater wire into said slit passage, and bending said tab portions of said passage back into their original position to completely enclose said heater wire within said passage whereby an electric current when passed through said heater wire will effect defrosting of said evaporator.

2. In the method of forming an evaporator having defrost means, the steps comprising superimposing one upon the other two sheets of metal having a stop-weld material arranged therebetween in at least two separate and continuous paths, one of said paths having the ends thereof exposed on at least one edge of said sheets, the other of said paths having an end exposed on one edge of said sheets, roll-bonding said two sheets into one by rolling the sheets at a temperature sufficiently high to cause said sheets to completely forge together into one except where said stop-weld material has been arranged, applying a high fluid pressure to separate said non-forged portions of said sheets to form a pair of continuous passages, slitting one of said passages along the length of said passage thereby forming tab portions adjacent said slit, turning said tab portions of said one passage outwardly, inserting a heater wire into said slit passage, and bending said tab portions of said passage back into their original positon to completely enclose sad heater wire within said passage whereby an electric current when passed through said heater wire will effect defrosting of said evaporator.

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