Jan. 30, 1962 C. C. WHISTLER, JR 3,018,544

REFRIGERATING APPARATUS

Filed April 29, 1957 2 Sheets-Sheet 1

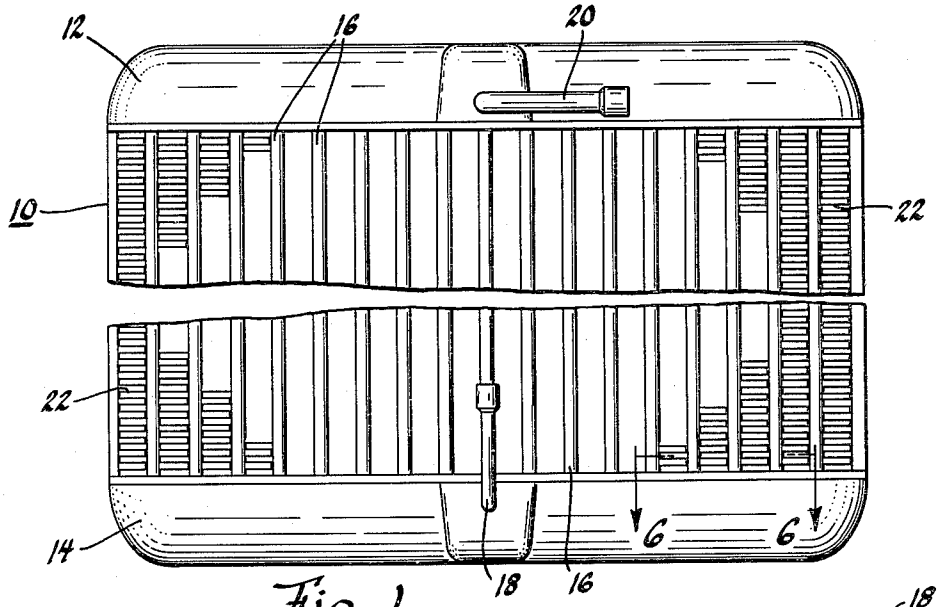

Fig. 1

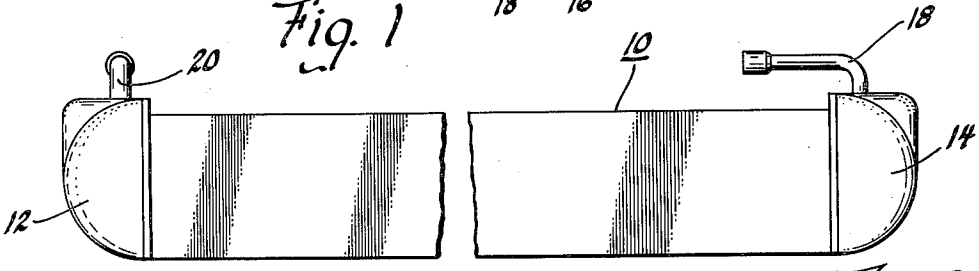

Fig. 2

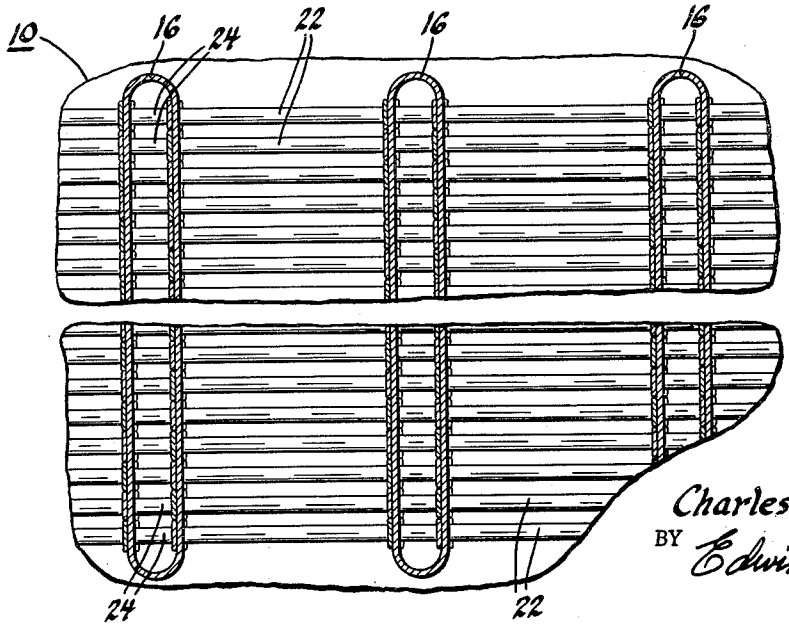

Fig. 6

INVENTOR.
Charles C. Whistler, Jr.
BY Edwin S. Dybvig
HIS ATTORNEY

Jan. 30, 1962 C. C. WHISTLER, JR 3,018,544

REFRIGERATING APPARATUS

Filed April 29, 1957 2 Sheets-Sheet 2

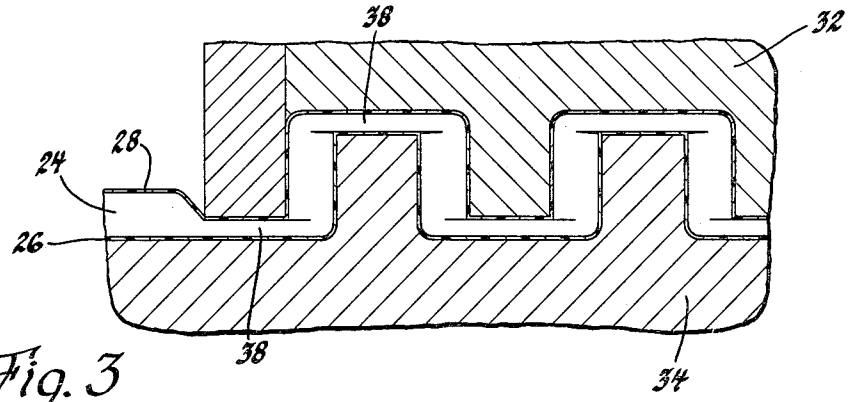

Fig. 3

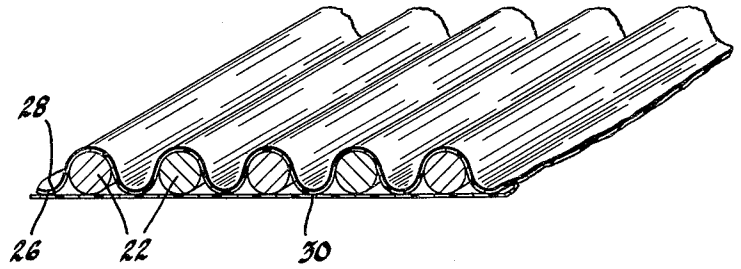

Fig. 4

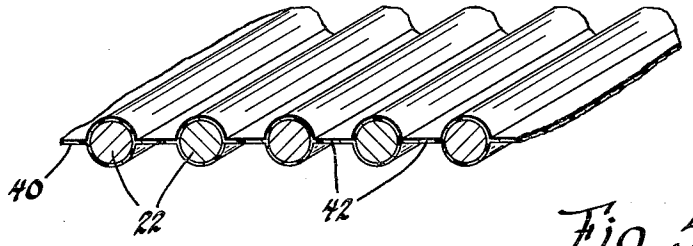

Fig. 5

INVENTOR.
Charles C. Whistler, Jr.
BY
Edwin S. Dybwig
HIS ATTORNEY

United States Patent Office 3,018,544 Patented Jan. 30, 1962

3,018,544

REFRIGERATING APPARATUS

Charles C. Whistler, Jr., Dayton, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed Apr. 29, 1957, Ser. No. 655,725
2 Claims. (Cl. 29—157.3)

This invention relates to refrigerating apparatus and more particularly to an improved form of refrigerant evaporator and the method of making the same.

One of the big problems in designing window air conditioners, automobile air conditioners and the like is that of keeping the size of the components at a minimum. In the case of the window units, the desirability of reducing the size of the various components and in particular the evaporators and the condensers has long been recognized not only from the aesthetic point of view, but also from a practical standpoint as many windows are not large enough to accommodate a large air conditioning unit. The problem of maintaining the size of the various units at a minimum is even more acute in automobile air conditioning systems wherein both the weight and size of the equipment must be maintained at a minimum.

It is an object of this invention to materially decrease the size of a refrigerant evaporator without reducing its capacity.

Still another object of this invention is to provide an evaporator having wire fins both internally and externally.

A further object of this invention is to provide an improved arrangement for handling the wires from which the fins are made both during the bending of the wires and during the brazing operation. More particularly it is an object of this invention to utilize a plastic material for holding a plurality of wire fins in parallel spaced relationship while the wires are being corrugated and while the wires are being assembled relative to the tubing and brazed to the tubing.

Still another object of this invention is to provide an improved arrangement for brazing wire fins to a heat exchanger in a manner so as to reduce the voids between the wire fins and the tube and so as to prevent the brazing material from bridging between or hanging on vertical sections of the wire fins.

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

In the drawings:

FIGURE 1 is a plan view of a heat exchanger constructed in accordance with the invention;

FIGURE 2 is a side elevational view of the evaporator shown in FIGURE 1;

FIGURE 3 is a fragmentary sectional view on an enlarged scale showing the wire fins in a fin forming die;

FIGURE 4 is a fragmentary sectional view on an enlarged scale showing the manner of holding the wires in parallel spaced relationship;

FIGURE 5 is a view similar to FIGURE 4 but showing a modification thereof; and

FIGURE 6 is a fragmentary sectional view on an enlarged scale taken substantially on line 6—6 of FIGURE 1.

For purposes of illustration there is shown a heat exchanger of the type suitable for use as an evaporator in a window air conditioning unit or the like whereas certain aspects of the invention are equally applicable to refrigerant condensers and heat exchangers of other types.

One of the big problems in designing a heat exchanger is that of providing an adequate amount of fin surface

to rapidly transfer the heat between the fluid within the tubing to the fluid flowing externally of the tubing. Another problem is that of maintaining the resistance to air flow over the fin surface at a minimum. Not withstanding the fact that it has long been recognized that wire fins are efficient both from the standpoint of heat transfer and also from the standpoint of offering a minimum amount of restriction to the flow of fluid thereover, wire fins have not been used extensively due largely to the problem of attaching the fins to the conduits of the heat exchanger.

Referring now to the drawings, wherein a preferred embodiment of the invention has been shown, reference numeral 10 generally designates a heat exchanger having a pair of headers 12 and 14 between which a series of fluid conduits 16 are arranged as shown. In the evaporator construction illustrated in the drawing the conduits 16 are arranged to lie horizontally between the headers 12 and 14. The refrigerant enters the header 14 through the line 18 and is adapted to leave through the line 20.

In the heat exchanger shown, a first set of external parallel wire fins 22 is provided as shown in FIGURE 1 between adjacent sections of the fluid conduits 16. These fins help to transfer the heat between the fluid flowing over the outside surfaces of the conduit 16 and the fluid flowing within the conduit 16. A second set of internal wire fins 24 is provided within the conduit 16. The fins 24 not only increase the turbulence of the fluid flowing through the conduit 16, but also serve to facilitate the heat transfer as well as serving to hold the tube 16 from becoming distorted when pressure is applied to the walls of the tubing.

As best shown in FIGURES 4 and 5 of the drawing, the wires 22 which are used in manufacturing the wire fins are held in a predetermined spaced parallel relationship by means of membranes or strips of plastic material 26 and 28. The membranes 26 and 28 are preferably sheets of polyethylene. For purposes of illustration there is shown an arrangement in which a first polyethylene sheet 26 has placed thereon a plurality of parallel fins 22 and thereafter a second polyethylene sheet 28 is placed thereover and by the application of heat or by the use of suitable bonding agents, the sheets 26 and 28 are bonded to one another at the points 30 and, if desired, to the wires themselves. The resulting assembly is then placed between a pair of forming dies 32 and 34 which serve to corrugate the wires with the base portion 38 of the corrugations being flattened so as to increase the available surface contact between the base portions of the fins and the walls of the fluid conduits 16. The process used in forming the external fins is much the same as the process used in forming the internal fins except that the internal fins are shorter than the external fins. FIGURE 3 shows the dies used in forming the internal fins.

FIGURE 5 shows a slightly modified arrangement for holding the fins in spaced parallel relationship. It is now well known that it is possible to pass parallel wires through an extruding die which serves to extrude plastic coating on the wires and to provide a connecting web of plastic between adjacent wires. Such processes are now commonly used in extruding insulated wires for electrical purposes and need no further description as no novelty is predicated on the extrusion process per se. FIGURE 5 of the drawings shows wires 22 which have a polyethylene material 40 which not only coats the wires but also includes web portions 42 which hold the wires in spaced relationship. The assembly shown in FIGURE 5 would be processed the same as that described in connection with forming corrugations in wires that are held together as shown in FIGURE 4 of the darwings.

It has been found that the polyethylene material is

particularly suitable for this purpose in that it burns almost 100% during immersion of the heat exchanger assembly in a 1000° F. ambient without leaving an objectional residue. In manufacturing the heat exchanger shown a first set of corrugated fins are inserted within the tube section **16** and a second set of corrugated fins are arranged between the adjacent tube sections **16** as shown in FIGURE 1. The tube sections **16** are then arranged to extend through suitable apertures in the header sections **12** and **14** in accordance with usual practice and then the entire assembly is heated to a temperature of 1130° F. The tubing **16** is of the type provided with a clading or a brazing alloy material both on its outer surface and on its inner surface whereby upon heating of the asembly to the above mentioned temperature the clading material serves to melt and braze the base portions of the fins to the walls of the tubing.

By virtue of the above described construction and process the brazing material is concentrated at the point where it is needed and no excess brazing material is left for coating the projecting wire fins or for blocking the space between the fins.

Insofar as certain aspects of the invention are concerned, the brazing material could be in the form of a coating on the wires or it could be separate from either the wires or the tubing. Thus it could be in the form of a thin ribbon, a wire, or powder placed adjacent the points of contact between the wire fins and the tubing.

The corrugations may be formed in the wires in any suitable manner such as by passing the wires between teeth on forming gears having teeth designed to corrugate the wires and simultaneously flatten the base portions of the corrugations. The flattened portions of the wires increase the area of contact between the fins and the tubing and also serve to reduce the obstruction of the wires to the flow over the wire fins.

After the internal wire fins **24** have been corrugated and assembled within the tubing **16**, the polyethylene material used for initially holding the wires in place during processing and assembly may be removed by chemically dissolving the polyethylene coating before the brazing operation whereby no residue of any kind will remain within the heat exchanger. Some or all of the polyethylene material on the external wire fins could also be removed by the use of a solvent if desired.

Any suitable plastic, such as polyvinyl chloride or polyvinyl acetate could be used in place of the polyethylene for holding the wires in place during processing. Any suitable solvent such as methanol, benzene, or toluol could be used for dissolving the plastic used for holding the wires in place during the initial assembly of the heat exchanger.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follow:

1. The method of manufacturing a heat exchanger which comprises holding a set of parallel wires in spaced parallel relationship by means of non-metallic heat decomposable material, forming corrugations in said set of wires and simultaneously flattening the base portions of said corrugations, placing said set of wires adjacent the outside wall of a conduit with base portions of said corrugations in contact with the external surface of said conduit in the presence of a fusible brazing material, and thereafter applying heat to said asembly so as to decompose said wire holding material and fuse said wires to the walls of said conduit.

2. The method of manufacturing a heat exchanger which comprises extruding a web of decomposable material about a set of parallel wires so as to hold said wires in spaced parallel relationship, forming corrugations in said set of wires and simultaneously flattening the base portions of said corrugations, placing said set of wires adjacent a wall of a conduit with the base portions of said corrugations in contact with the surface of said conduit and in the presence of a fusible brazing material, and thereafter applying heat to said assembly so as to decompose said wire holding material and fuse said wires to the wall of said conduit.

References Cited in the file of this patent

UNITED STATES PATENTS

1,780,732	Young	Nov. 4, 1930
1,881,610	Hyde	Oct. 11, 1932
2,328,302	Simison	Aug. 31, 1943
2,500,501	Trumpler	Mar. 4, 1950
2,505,619	Holm	Apr. 25, 1950
2,537,797	Simpelaar	Jan. 1, 1951
2,573,161	Tadewald	Oct. 30, 1951
2,585,443	Cox	Feb. 12, 1952
2,595,457	Holm	May 6, 1952
2,596,285	Peters	May 13, 1952
2,678,808	Gier	May 18, 1954
2,807,074	Schroeder	Sept. 24, 1957
2,869,222	Whistler	Jan. 20, 1959
2,916,055	Brumbach	Dec. 8, 1959