United States Patent

Mosier et al.

[15] **3,689,972**

[45] **Sept. 12, 1972**

[54] **METHOD OF FABRICATING A HEAT EXCHANGER**

[72] Inventors: **James A. Mosier; Harold H. Dolister,** both of Racine, Wis.

[73] Assignee: **Modine Manufacturing Company**

[22] Filed: **Nov. 19, 1970**

[21] Appl. No.: **91,027**

[52] **U.S. Cl.** .....**29/157.3 R,** 165/175

[51] **Int. Cl.** **B21d 53/02**

[58] **Field of Search**.....29/157.3 R; 165/175

[56] **References Cited**

UNITED STATES PATENTS

3,307,622	3/1967	Oddy	165/175 X
3,238,606	3/1966	Tolson	29/157.3 R
1,278,243	9/1918	Sonneborn	165/175
2,153,806	4/1939	Karmazin	29/157.3 D
3,275,070	9/1966	Beatenbough et al	165/175 X
3,310,869	3/1967	La Porte et al.	29/157.3 A

Primary Examiner—John F. Campbell
Assistant Examiner—Donald C. Reiley, III
Attorney—Hofgren, Wegner, Allen, Stellman & McCord

[57] **ABSTRACT**

A heat exchanger and a method of making a heat exchanger comprising an elongated integral metal tank-header with spaced tubes interfitted in openings formed by displacing metal of the header portion to form flanges. The flanges are bonded to the tube ends and the tank-header before and after the bonding has a curved cross section including the flange areas. The method of forming the heat exchanger in which an integral metal tank-header is provided of rounded externally convex cross section including a longitudinal portion comprising an elongated convex header, providing spaced openings in this header each defined by a flange of metal displaced from the header in forming the opening and each flange having a curved bonding surface bonding the end of the tube in each opening with bonding material located between the tubes and the surface on the corresponding flange and then reshaping the tank-header after the bonding.

7 Claims, 8 Drawing Figures

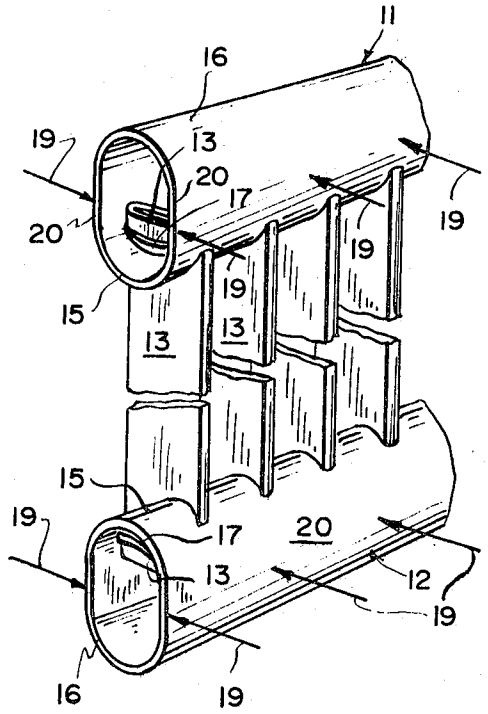


FIG.1

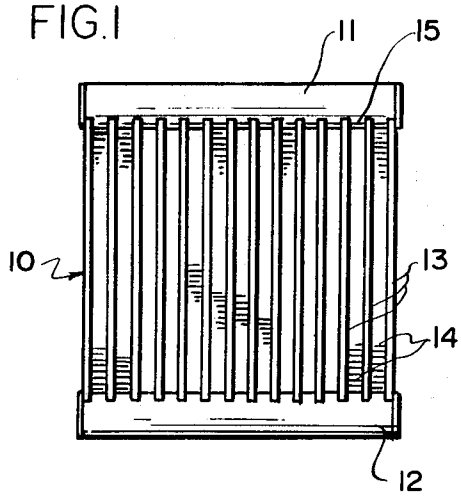


FIG.2

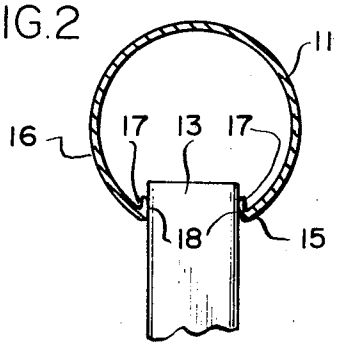


FIG.3

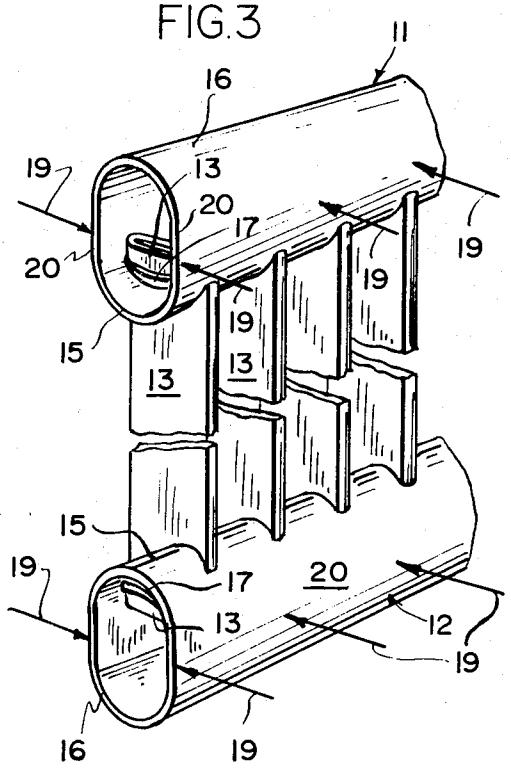


FIG.4

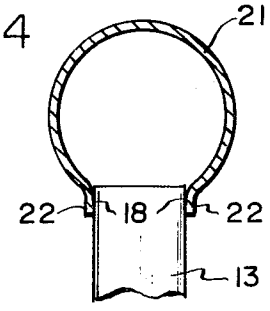
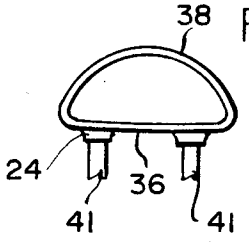


FIG.5



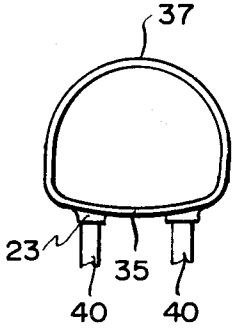


FIG.6

FIG.7

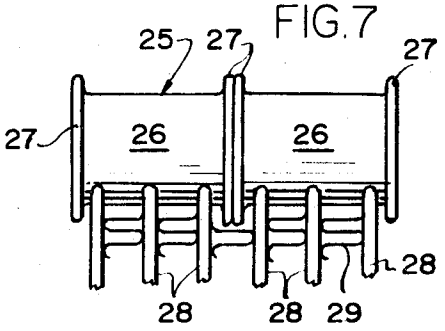
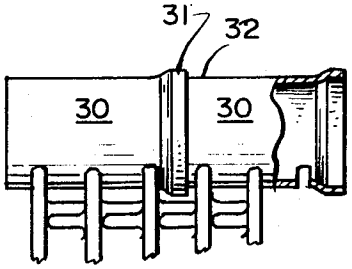


FIG.8



INVENTORS.
JAMES A. MOSIER
HAROLD H. DOLISTER.
BY Hofgren, Wegner, Allen, Stellman & McCord
ATTORNEYS.

METHOD OF FABRICATING A HEAT EXCHANGER

FIELD OF THE INVENTION

One of the features of this invention is to provide a heat exchanger comprising at least one elongated integral metal tank-header having a plurality of openings in the header portion defined by flanges of metal displaced from the header in providing the openings, a tube end in each opening and bonded to its flange with bonding material and the tank-header having a flange area in the vicinity of each flange with the cross sectional curve of the arc of a circle and cross sectional areas spaced from these flange areas of a curvature different from those of the flange areas.

This invention also relates to a method of making a heat exchanger comprising providing an integral metal tank-header of rounded convex cross section, providing spaced openings in the header each defined by a flange of metal displaced from the header in forming the opening and each flange having a curved bonding surface, bonding the end of a tube in each opening and then reshaping the tank-header after the bonding in areas spaced from the flanges to satisfy space requirements or shape requirements of the heat exchanger.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of a heat exchanger embodying the invention but prior to the reshaping of the tanks.

FIG. **2** is an enlarged cross sectional view through one of the tank-headers.

FIG. **3** is a fragmentary perspective view illustrating the heat exchanger after reshaping the tanks to satisfy shape or space requirements.

FIGS. **4**, **5** and **6** are views similar to FIG. **2** but showing three additional embodiments of the invention.

FIG. **7** is a fragmentary side elevational view illustrating a further embodiment of the invention.

FIG. **8** is a view similar to FIG. **7** but illustrating an additional embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the embodiment of FIGS. **1**, **2** and **3** the heat exchanger **10** comprises opposite and parallel tank-headers **11** and **12** interconnected by spaced parallel tubes **13** with each pair of adjacent tubes having customary serpentine fins **14** spanning the distance between.

As illustrated by the tank-header **11** in FIG. **2**, each header **11** and **12** is of rounded generally circular cross section. In the embodiment of FIG. **2** the header portion **15** which is elongated and integral with the tank **16** contains inturned flanges **17** comprising the entire amount of metal displaced from the header portion **15** in piercing to provide openings for the ends of the tubes **13**.

Each flange **17** is of generally oval shape to fit snugly against the oval end of its tube **13**. As can be seen in the drawings each flange **17** has a large bonding surface pressed against the tube **13** and receiving the bonding metal layer **18** to form the joint.

After the tubes and headers have been thusly joined the tanks **16** of upper and lower tank-headers **11** and **12** are reformed as by applying lateral reshaping pressure indicated by the arrows **19**. In the embodiment illustrated this reforming and reshaping pressure is sufficient to distort the metal of the tanks to beyond their yield points so that they retain this altered shape. As is shown in FIG. **3** this reforming provides substantially parallel lateral sides **20** on the tanks. In general, the reshaping after assembly and joining of the tank-headers and tubes alters the shape of the tanks to satisfy shape or space requirements.

In the embodiment of FIG. **4** the tank **21** is generally similar in shape to the tank **11** but here the flanges **22** extend outwardly rather than inwardly. In the embodiments in FIGS. **5** and **6** the flanges **23** and **24** also extend outwardly while the headers **35** and **36** are curved to a larger curvature than are the corresponding tanks **37** and **38**. In each of these embodiments of FIGS. **5** and **6** the tubes **40** and **41** are bonded to the corresponding flanges prior to reshaping of the tanks **37** and **38**.

In this invention the combined tank and header is formed in the round and then reshaped with external pressure as indicated at **19** in FIG. **3** to the configuration desired. After forming the tank and header combination the header is provided with the plurality of openings such as by piercing with external pressure in conjunction with the flanges **17** of the FIGS. **2** and **3** embodiment or with internal pressure as with the FIGS. **4**, **5** and **6** embodiments and in all embodiments the flanges contain the entire amount of metal displaced by piercing so that there is no cutting and removal of metal. This provides a more strongly reinforced heat exchanger with strong joints as indicated by the bonding metal **18** in both the embodiments of FIGS. **2** and **4** with this bonding metal being in a layer between the flanges and the adjacent tube surfaces. This construction provides a lap joint, results in a large area for joining which may be by brazing or the like and forms a guided lead in defined by the inner surfaces of the flanges for inserting the tube end which is received snugly within its flange by sizing the opening formed by the flange to be substantially the same as the surface area of the corresponding tube end. In addition, this arrangement provides a tapered fillet for the brazed joint which results in an extremely strong and secure joint and the resulting brazed joint follows the arc of a circle which is the most stable joint when subjected to internal pressure.

With this structure the reshaping after forming the joints between the headers and tubes retain all of the advantages of strength and deformation resistance in the header portion **15**, for example, while permitting reshaping deforming of the tank **20** itself.

One preferred arrangement of the displaced metal flanges is illustrated in FIGS. **4–6** wherein the metal of the flanges **22**, **23** and **24** is distorted outwardly to form external flanges. This results in better fluid flow patterns within the tanks and into the tubes **13**, **40** and **41**, reduces fluid erosion of the tube wall and reduces restrictions to fluid flow within the tanks.

In the embodiment of FIG. **7** the tank-header **25** is in the form of aligned individual segments **26** joined together at end flanges **27** on each which as illustrated in this embodiment are in abutting relationship. The individual segments **26** have attached thereto the spaced parallel tubes **28** as in the other embodiments with ad-

jacent pairs of tubes being interconnected by heat exchange fins **29**.

The embodiment of FIG. **8** differs from that of FIG. **7** in that the segments **30** of this embodiment are joined by having their ends shaped to provide cooperating bell **31** and pipe **32** fittings. In both embodiments of FIGS. **7** and **8**, however, the assembly of the tubes joined to the tank-header is made and then the tank-header is reformed by applying pressure to its final shape shown in these two Figures.

Having described our invention as related to the embodiments shown in the accompanying drawings, it is our intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the appended claims.

We claim:

1. The method of making a heat exchanger, comprising: providing an integral metal tank-header of rounded convex cross section including a longitudinal portion comprising an elongated convex header; providing spaced openings in said header each defined by a flange of metal displaced from said header in forming the opening and each flange having a curved bonding surface; bonding the end of a tube in each said opening located between said tube and its flange bonding surface; and reshaping and reforming said tank-header by distorting said metal to beyond its yield point after said bonding in areas spaced from said flanges with the result that the tank-header retains its new shape.

2. The method of claim **1** wherein said flanges extend inwardly of said tank-header.

3. The method of claim **1** wherein said flanges extend outwardly of said tank-header.

4. The method of claim **1** wherein said reshaping provides a flat surface on said tank-header laterally of said header.

5. The method of claim **1** wherein said tank-header comprises cylindrical segments joined end-to-end, each said segment being a complete cylinder.

6. The method of claim **1** wherein adjacent segments are joined by a bell and interfitted pipe joint integral with said segments.

7. The method of claim **1** wherein adjacent segments are joined by outwardly extending abutting flanges.

* * * * *