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(54) **A baffle for a heat exchanger**

(57) A method for forming an internal, integral baffle for a tube and fin type heat exchanger is disclosed. The baffles are formed by plastically deforming a top wall (50) of the manifold against the bottom wall (52) of the

manifold to form a depression (58). A slit (59) is formed in the depression, the slit (59) allowing a bonding agent to secure the top wall (50) to the bottom wall (52) to secure the baffle within the manifold.

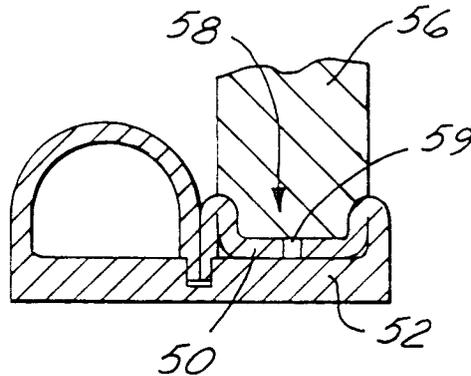


FIG.8

**EP 0 840 083 A2**

## Description

The present invention relates generally to heat exchangers used in automotive air conditioning systems, such as condensers, evaporators and oil coolers. More particularly, the present invention relates to a method for forming an internal, integral baffle in a heat exchanger.

Reference is made to co-pending U.S. Patent applications "Heat Exchanger Manifold," Serial No. 08/739562 and "A Heat Exchanger," Serial No. 08/739636.

Fin and tube type heat exchangers are commonly used in vehicle, industrial and residential environments for heating and cooling purposes. Typically, these heat exchangers utilise a plurality of tubes through which the fluid to be heated or cooled passes. The number of tubes utilised depends on the thermal capacity requirements of the fin and tube heat exchanger. In order to connect these tubes together so that the fluid can flow through the tubes, manifolds are used having a series of openings corresponding to and mating with the ends of the tubes. The manifolds have an inlet port and an outlet port which circulate the fluid through the heat exchanger and then returns the fluid to a remote location for subsequent recycling.

In multipass heat exchangers, the heat exchanger fluid makes multiple passes through the heat exchanger to increase its efficiency. These multiple passes are accomplished by obstructing the fluid flow at key locations and forcing the fluid across the heat exchanger. Typically, the obstructions are baffles placed within the manifold. Several methods are known for placing baffles within a manifold. In one method, a circular disk of material is placed within a predefined aperture in the manifold and welded there. In another method, such as disclosed in U.S. Patent No. 5,090,477 a baffle is mechanically formed by crimping the manifold so that one portion of the manifold wall contacts an opposite portion of the manifold wall. The '477 patent teaches that because of the plastic deformation of the manifold wall, a leak tight seal is formed and brazing is not required further secure the baffle within the manifold. However, if the manifold is used on a heat exchanger requiring extremely high internal pressures, the baffle may leak. Therefore it would be advantageous to provide a manifold with an internally formed baffle that can withstand high pressures.

It is a feature of the present invention that manifolds with internally formed baffles can withstand higher operating pressures with no leaking.

The present invention overcomes the difficulties and deficiencies associated with prior art devices by providing a method of forming internal, integral baffles at baffle locations in a heat exchange manifold, comprising the steps of permanently collapsing the manifold at the baffle locations such that the manifold wall top and the manifold wall bottom form a generally U-shaped de-

pression in the manifold and forming a slit in the U-shaped depression. The method further includes the steps of applying a brazing material to the manifold, causing the brazing material to flow through the slit and between the manifold wall top and manifold wall bottom and processing the manifold at predetermined conditions to secure the manifold wall top and bottom together.

The method provides the advantages of a stronger bond strength at the baffle, thus increasing the burst strength of the manifold.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1 and 2 are perspective views of two different tube and fin heat exchangers including baffles structured in accord with the principles of the present invention;

Figure 3 is a perspective, enlarged view of a portion of Figure 1 showing a baffle of the present invention; Figure 4 is a cross-sectional view of the baffle of Figure 1 taken along line 4-4;

Figure 5 is a cross-sectional view of Figure 4 taken along line 5-5;

Figure 6 is a perspective view of a tool used in fabricating a baffle in accord with the principles of the present invention;

Figure 7 is a perspective view of a tool used in fabricating a baffle in accord with the principles of the present invention; and

Figure 8 is a cross-sectional view of Figure 7 taken along line 8-8.

Referring now to the drawings, Figures 1 and 2 show two different types of tube and fin heat exchangers 10. Each includes a plurality of tubes 12 with heat dissipative fins 14 interposed between each of the tubes 12. In Figure 1, the heat exchanger includes U-shaped tubes 12 in which the free ends of the tubes matingly engage a manifold 16 disposed at only one end of the heat exchanger 10. As shown in Figure 1, manifold 16 is a double chambered manifold having a first fluid conduit 18 and a second fluid conduit 20. Figure 2 shows a "parallel flow" type of heat exchanger wherein a plurality of generally straight tubes 12' are interposed between a pair of fluid manifolds 16'. Each of the heat exchangers includes an inlet port 22 for receiving fluid therein and an outlet port 24 for discharge of fluid therefrom. As will be explained more fully below, the manifolds 16 and 16' of each type of heat exchanger include a plurality of integrally formed, crimped baffles 26 for directing fluid through the heat exchanger according to a predefined pathway. The baffles 26 of the present invention are essentially the same in each heat exchanger, therefore, the description of the baffles 26 will be made with reference to the heat exchanger of Figure 1. However, it should be apparent that the description of the baffles 26

and the method of forming such baffles applies equally as well to the parallel flow heat exchanger of Figure 2.

In accordance with principles well known in the heat exchanger art, fluid to be cooled (or heated) enters manifolds 16 through inlet port 22 and is directed through the plurality of U-shaped tubes 12 wherein the fluid is cooled by a secondary fluid, such as air, passing over the fins 14. The baffles 26 and the manifold 16 direct the fluid through the U-shaped tubes wherein the fluid eventually discharges from outlet port 24. It should be apparent to those skilled in the art that the heat exchanger of Figure 1 utilises a manifold having a pair of longitudinal fluid conduits although the present invention may be utilised in conjunction with a manifold having a single fluid conduit. As shown in Figure 1, the heat exchanger is a condenser, although the principles of the present invention can be applied to other types of heat exchangers as well.

The manifold 16 is fabricated from an extruded aluminium alloy such as SAE 3003, 3102, or 6062 or any of another of known types of deformable materials. The manifold 16 can be formed according to any of a number of known methods. For example, one such method is taught in U.S. Patent No. 5,190,101, assigned to the assignee of the present invention, the disclosure of which is hereby incorporated by reference. The manifold 16 must include a fluid conduit 18, 20 (Figure 3) as well as fluid conducting passages which matingly engage the tube ends so that fluid can flow through the plurality of tubes. One type of fluid-conducting passage is formed as a plurality of apertures or raised fluid pipes. These passages communicate with the fluid conduits 18, 20 of the manifold 16.

After the fluid conduits and passages have been formed, the baffles 26 are then mechanically crimped into each of the fluid conduits 18, 20 according to a predefined location to achieve the desired circulation of fluid. The crimping operation may be achieved in any of a number of known mechanical processes and one such process is shown in Figures 6-8. The fluid conduits 18, 20, define an arcuate top wall 50 and a bottom wall 52. The manifold is placed into a die 54 in which it is securely held. A vertically reciprocating punch 56 having a slit producing member 60 on an end thereof is forced into the top wall 50 of the conduit until the punch plastically deforms the top wall 50 to the bottom wall 52 to form a depression 58 having a slit 59 therein. As shown in Figure 8, the depression 58 is generally U-shaped and includes the slit 59 therein. In either method, an integrally formed baffle is created.

After the baffles have been formed and the ends of the manifold have been crimped, the manifold assembly is washed in a degreasing solution. From there, the inlet port 22 and outlet port 24 are formed and assembled to the manifold according to known manufacturing processes. The manifold is coated with a brazing material which typically includes a fluxing agent. The brazing material can be in the form of a paste or a wire which is

placed along the longitudinal length of the manifold 48 and in the depressions 58. The manifold assembly is then placed in a brazing oven to form a weld seam or brazed joint along the longitudinal length of the manifold as shown at 48 in Figure 4 between each of the fluid conduits 18 and 20. As shown in Figures 4 and 5, during this step, the molten flux/braze material 66 flows through the slits 59 by capillary flow to bond the top wall 50 to the bottom wall 52 of the manifold. By actively bonding the top and bottom walls together, a stronger baffle is formed than without the bonding. This increases the burst strength of the manifold over mechanical crimps alone, and reduces leakage at the baffle. The transverse ends of the fluid conduits are also sealed at this point in the process. The ends may also include a slit for the same purpose as explained above.

After the manifold has been manufactured according to the above process, the U-shaped tubes are connected to the manifold 16. The free ends of the U-shaped tube of the heat exchanger matingly engage fluid passage apertures of the manifold. Fins 14 and end plates 62 complete the assembly. Solder joints are formed at each fluid passage to ensure a leak-free, secure joining of the manifold to the U-shaped tube ends. The manifold may be joined to the heat exchanger in any of a number of known processes such as by vacuum brazing, controlled atmosphere brazing or welding the manifold thereto.

In view of the above, variations and modifications to the present invention will no doubt occur to those skilled in the art. For example, the method of manufacturing the manifold from a single extruded piece of aluminium can also be performed for a single manifold as well as a double manifold. Various other materials may also be chosen to fabricate the manifolds and the present invention is not meant to be limited solely to those specified above.

#### 40 Claims

1. A method for forming an internal baffle between the ends of a substantially rigid tube comprising the steps of:

45 deforming a section of the tube wall (50) toward an opposing section of tube wall (52) until said one section abuts said opposing section;  
 50 forming a slit (59) in one of said sections of the tube wall;  
 applying a brazing material (66) to the tube;  
 causing the brazing material (66) to flow through the slit (59) and between the abutting sections; and  
 55 processing the tube at predetermined conditions to secure said sections to one another.

2. A method of forming internal, integral baffles at baf-

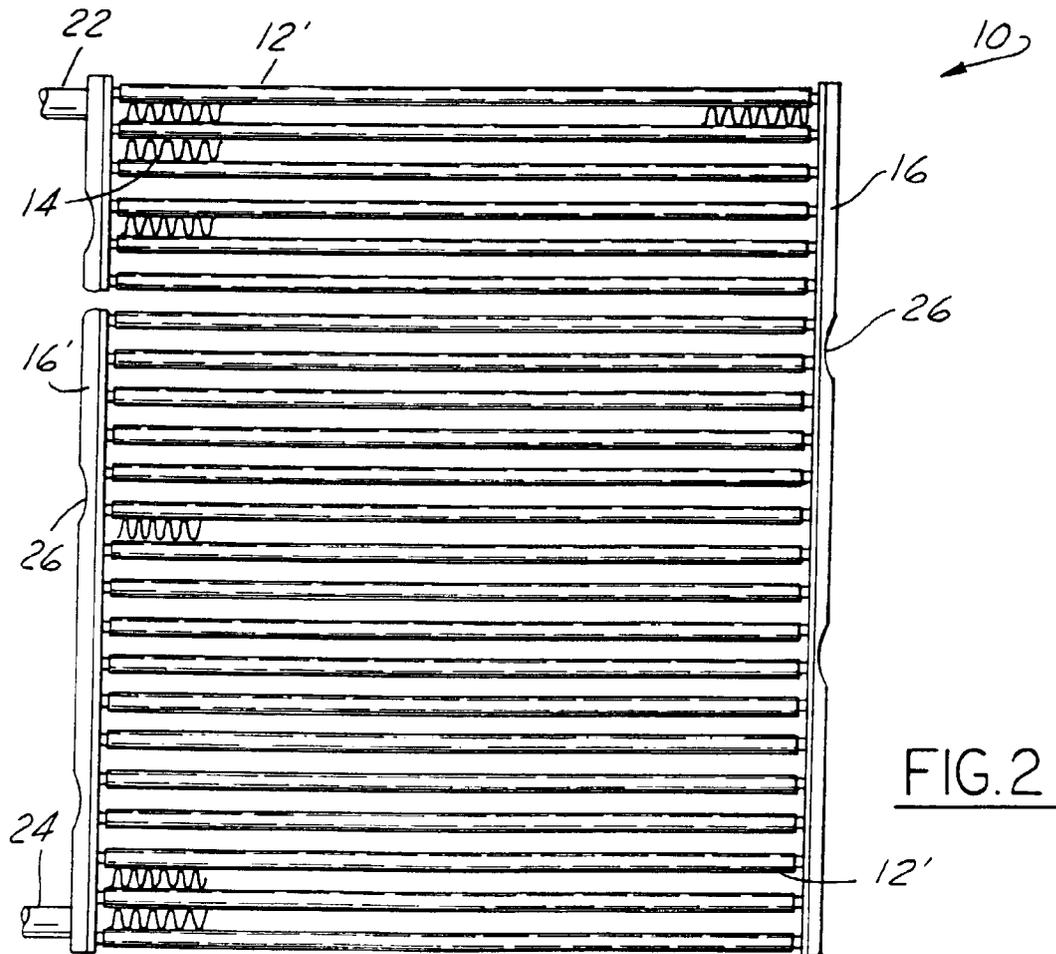
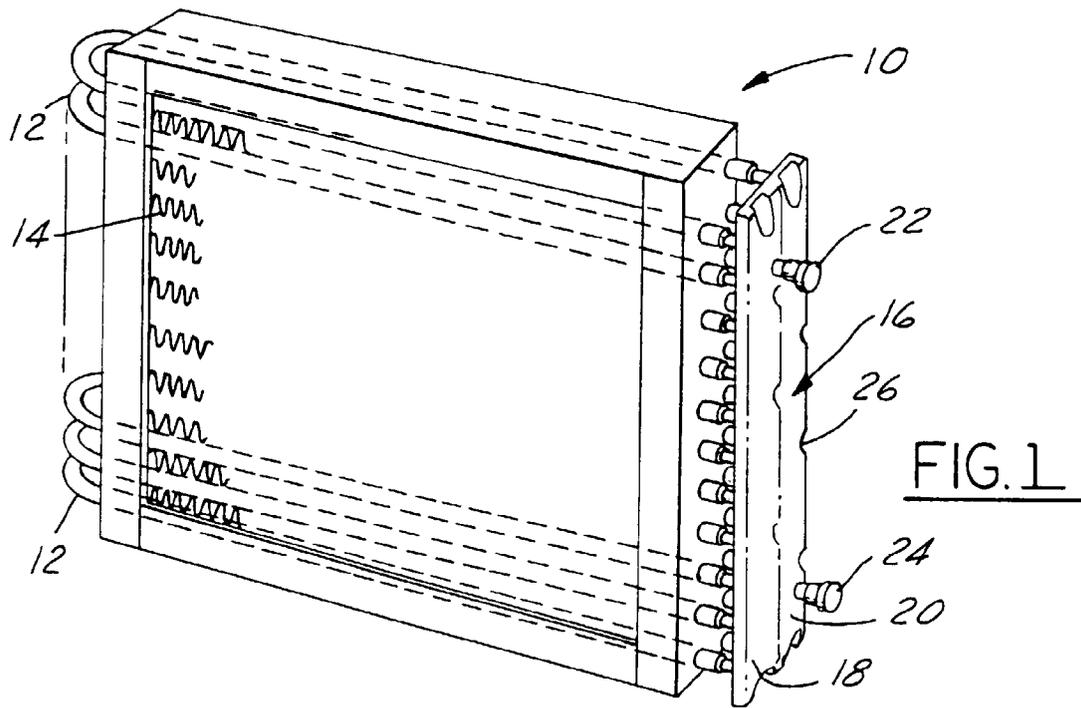
file locations in a manifold for use in a heat exchanger, comprising the steps of:

permanently collapsing the manifold at the baffle locations such that the manifold wall top and the manifold wall bottom form a generally U-shaped depression in the manifold; 5  
forming a slit in the U-shaped depression;  
applying a brazing material to the manifold; 10  
causing the brazing material to flow through the slit and between the manifold wall top and manifold wall bottom; and  
processing the manifold at predetermined conditions to secure said manifold wall top and bottom together. 15

3. A method according to claim 2, wherein the collapsing step is carried out by contacting the manifold wall top with a punch and applying a force thereto. 20
4. A method according to claim 2, wherein the step of forming a slit in one of the manifold walls comprises the step of applying a punch having a slit producing end against the manifold wall top until the slit producing end contacts the manifold wall bottom. 25
5. A method according to claim 2, wherein the deforming step forms a substantially U-shaped internal seam of double wall thickness. 30
6. A method according to claim 2, wherein the step of causing the brazing material to flow through the slit is carried out by capillary flow.
7. A method according to claim 2, wherein said processing step is carried out in a controlled atmosphere brazing furnace. 35
8. A method according to claim 2, further including the step of applying a fluxing material prior to applying the brazing material. 40
9. A method according to claim 2, wherein the brazing material includes a fluxing agent. 45
10. A method according to claim 2, wherein said internal baffles are formed in a tube for use in an automotive condenser. 50

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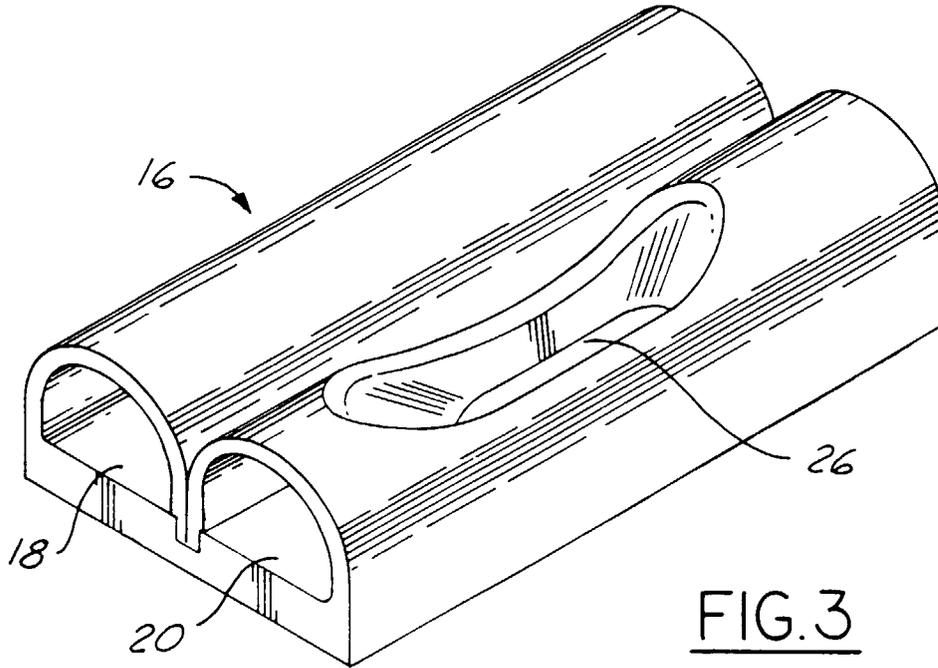


FIG. 3

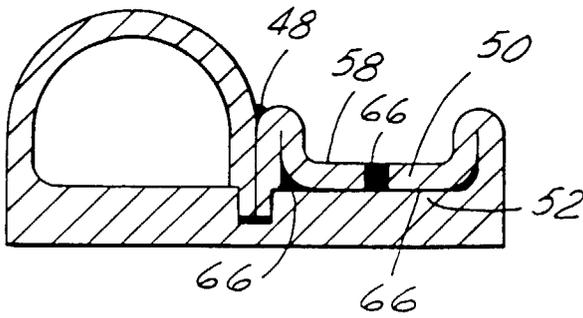


FIG. 4

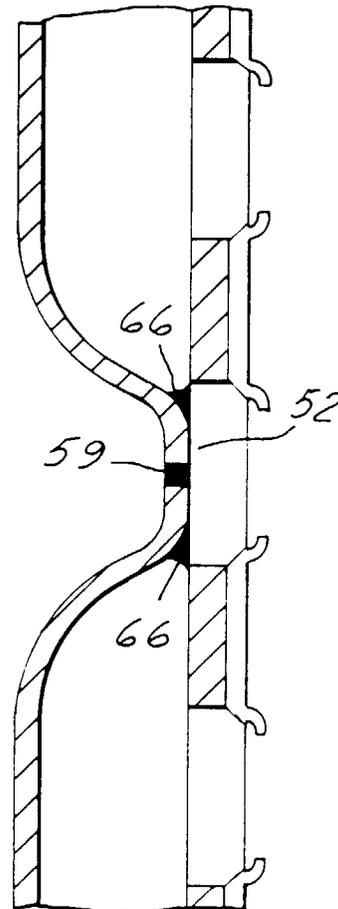


FIG. 5

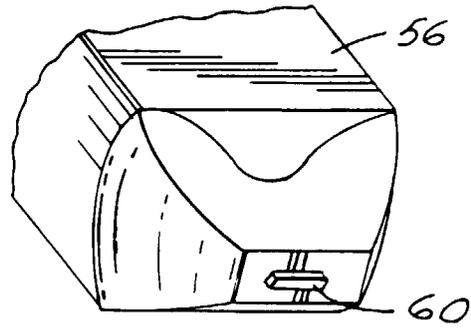


FIG. 6

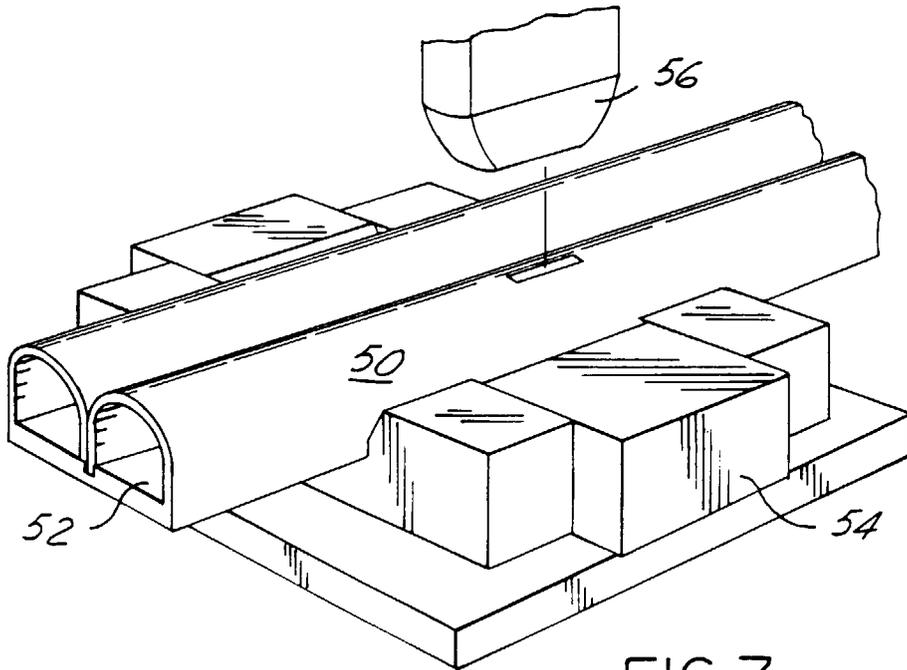


FIG. 7

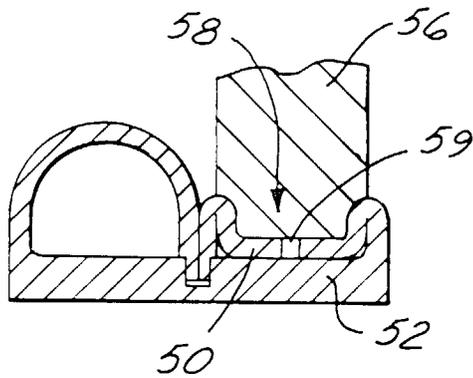


FIG. 8