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(54) **EVAPORATOR AND METHOD OF MAKING SAME**

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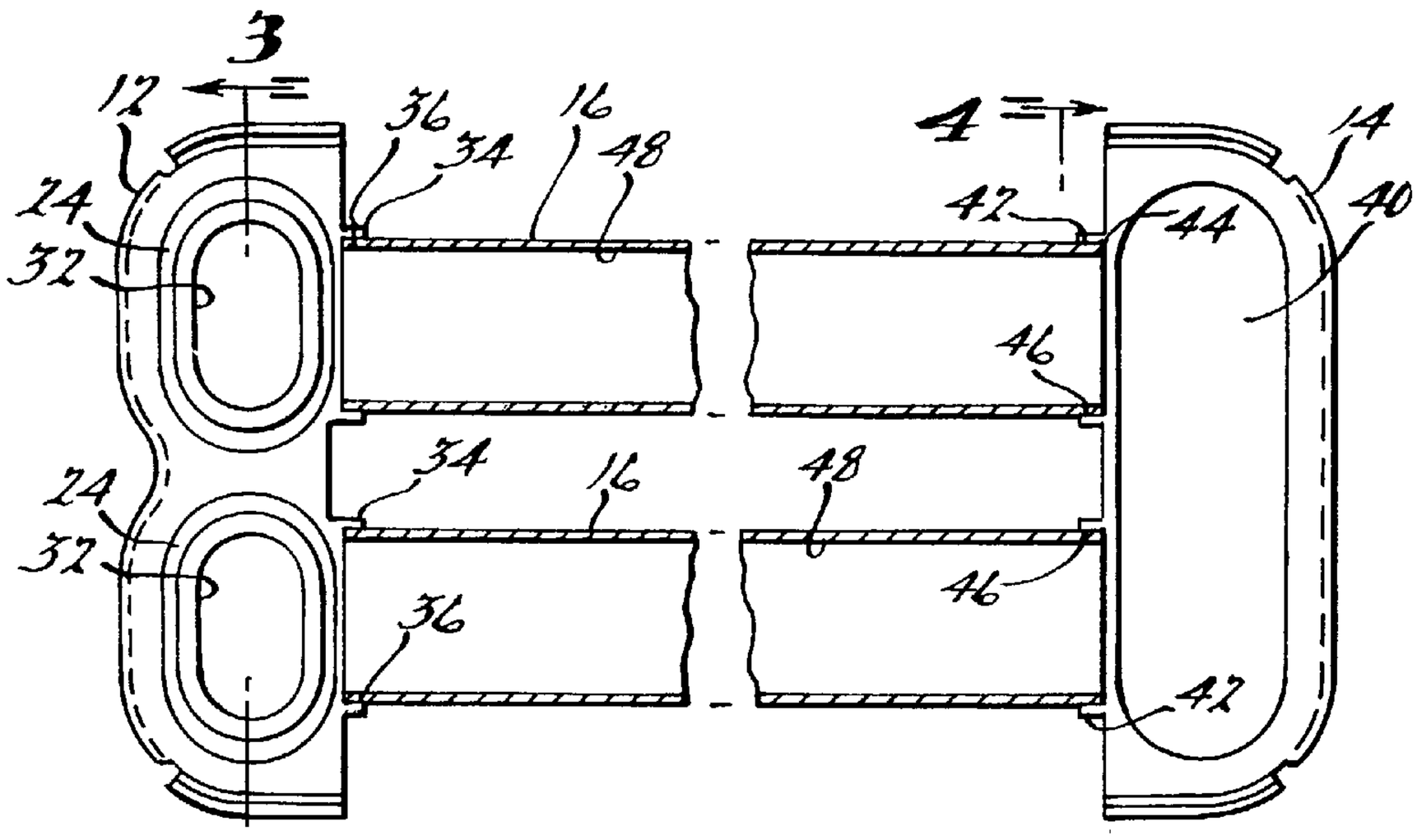
(57) **ABSTRACT**

An evaporator and method of making same includes a first end tank, a second end tank spaced from and opposing the first end tank, and a plurality of extruded fluid carrying tubes extending between and in fluid communication with the first end tank and the second end tank. The first end tank and the second end tank are formed as stampings.



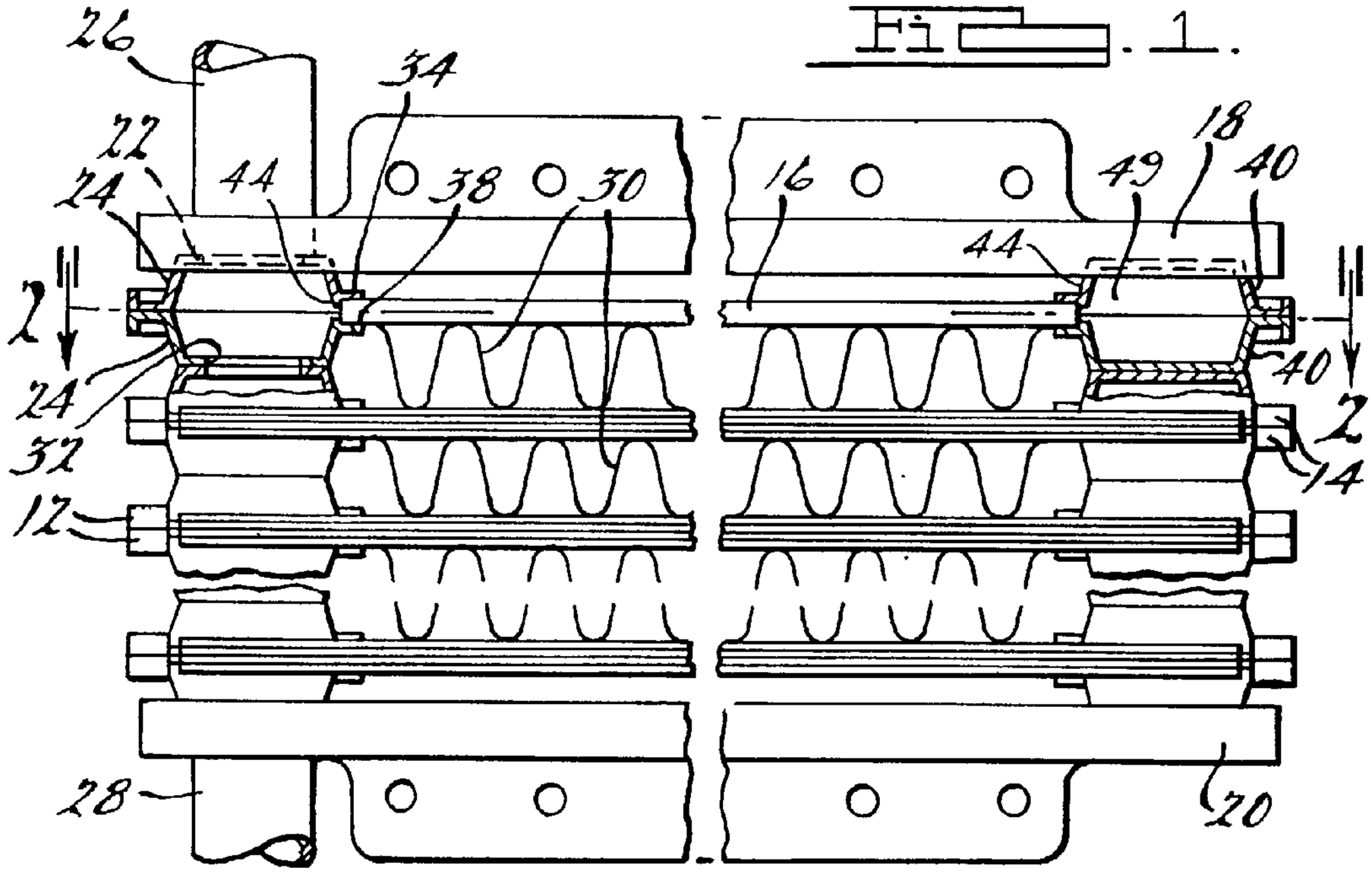


Fig. 1.

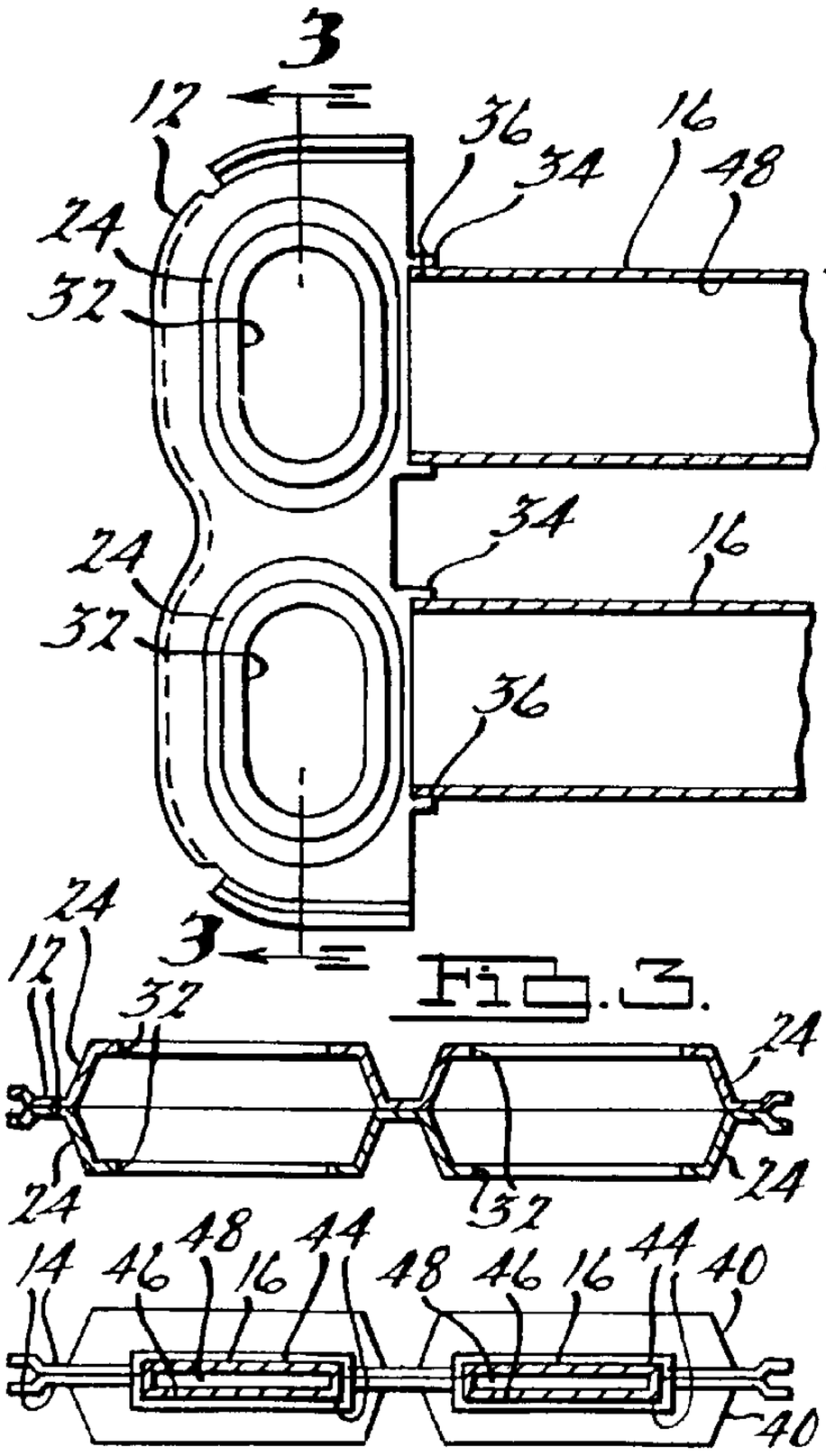


Fig. 3.

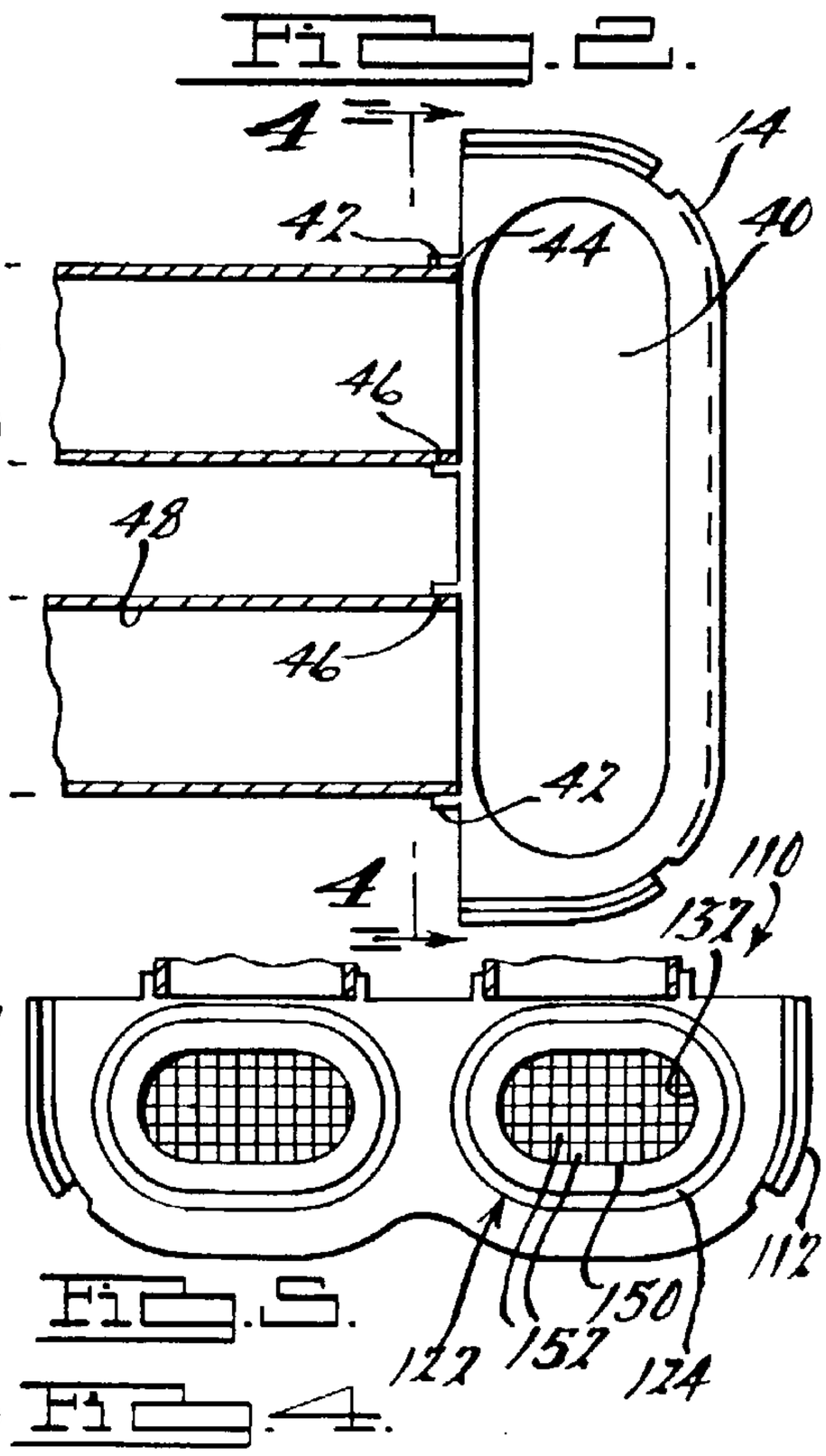


Fig. 2.

Fig. 5.

Fig. 4.

EVAPORATOR AND METHOD OF MAKING SAME

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] The present application is a divisional of U.S. patent application Ser. No. 09/470,402, filed Dec. 22, 1999.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates generally to heat exchangers and, more specifically, to an evaporator and method of making same with stamped end tanks and extruded tubes for an air conditioning system in a motor vehicle.

[0004] 2. Description of the Related Art

[0005] It is known to provide a heat exchanger such as an evaporator for an air conditioning system in a motor vehicle. The evaporator typically receives a fluid such as a refrigerant. The evaporator normally includes a plurality of flow passages, which may, for example, be constructed from flat plates or extruded, tubes extending between opposite manifolds or end tanks. The evaporator also includes a plurality of cooling fins disposed between the flow passages. Evaporators are generally much thicker than condensers, and thus require as manifolds or end tanks that may be as wide or wider than fifty-five millimeters. One type of evaporator, often referred to as an extruded tube evaporator, includes a plurality of extruded tubes extending between the end tanks to direct the refrigerant through a plurality of flow paths. However, the end tanks typically used for extruded tube condensers do not have the required strength due to the vastly increased surface area and thus force present in such a wide heat exchanger. Another type of evaporator, often referred to as a plate-fin evaporator, includes a plurality of plates extending between the end tanks to direct the refrigerant through a plurality of flow paths. The end tanks are stamped by using a drawn-cup process.

[0006] Therefore, it is desirable to provide an evaporator with stamped end tanks and extruded tubes. It is also desirable to combine the benefits of stamped plate-fin evaporators and extruded tube heat exchangers.

SUMMARY OF THE INVENTION

[0007] Accordingly, the present invention is an evaporator including a first end tank, a second end tank spaced from and opposing the first end tank, and a plurality of extruded fluid carrying tubes extending between and in fluid communication with the first end tank and the second end tank. The first end tank and the second end tank are formed as stampings.

[0008] One advantage of the present invention is that a new evaporator and method of making same are provided for an air conditioning system of a motor vehicle. Another advantage of the present invention is that the evaporator has extruded tubes and stamped end tanks. Yet another advantage of the present invention is that the evaporator combines the benefits of stamped plate-fin evaporators and extruded tube heat exchangers. Still another advantage of the present invention is that the evaporator uses a drawn-cup manifold, stamped such that, when assembled, accept extruded tubes for passage of refrigerant. A further advantage of the present invention is that the evaporator has the increased heat transfer surface area of the extruded tube combined with the strength and manufacturing flexibility of a drawn-cup manifold.

[0009] Other features and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a fragmentary elevational view of an evaporator, according to the present invention.

[0011] **FIG. 2** is a sectional view taken along line **2-2** of **FIG. 1**.

[0012] **FIG. 3** is a sectional view taken along line **3-3** of **FIG. 2**.

[0013] **FIG. 4** is a sectional view taken along line **4-4** of **FIG. 2**.

[0014] **FIG. 5** is a plan view of another embodiment, according to the present invention, of the evaporator of **FIG. 1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0015] Referring to the drawings and in particular **FIG. 1**, one embodiment of a heat exchanger such as an evaporator **10**, according to the present invention, is shown for an air conditioning system (not shown) in a motor vehicle (not shown). The evaporator **10** includes a pair of generally parallel manifolds or end tanks, first end tank **12** and second end tank **14** spaced apart a predetermined distance, pairs of which are joined together in a face-to-face relationship to form a stack. The evaporator **10** also includes a plurality of generally parallel, flat tubes **16** extending between the end tanks **12,14** and conducting fluid such as a refrigerant between them. The evaporator **10** includes oppositely disposed first and second mounting plates **18** and **20** at ends of the stack. The evaporator **10** further includes a fluid inlet **26** for directing fluid into the evaporator **10** formed in the first mounting plate **18** and a fluid outlet **28** for directing fluid out of the evaporator **10** formed in the second mounting plate **20**. The fluid inlet **26** and fluid outlet **28** fluidly communicate with flow headers, generally indicated at **22**, formed by bosses **24** on each of the end tanks **12,14**. The evaporator **10** also includes a plurality of convoluted or serpentine fins **30** disposed between the tubes **16** and attached to an exterior of each of the tubes **16**. The fins **30** serve as a means for conducting heat away from the tubes **16** while providing additional surface area for convective heat transfer by air flowing over the evaporator **10**. It should be appreciated that the evaporator **10** could be used as a heat exchanger in other applications besides motor vehicles.

[0016] Referring to **FIGS. 2 through 4**, the first and second end tanks **12,14** extend laterally and are substantially planar or flat. The first end tank **12** includes at least one, preferably a pair of raised bosses **24** spaced laterally. The bosses **24** extend laterally and vertically. Each boss **24** has an aperture **32** extending therethrough. Each boss **24** also includes a flange **34** extending axially and having a generally U-shaped cross-section to receive an end of the tube **16**.

The flange **34** may include a projection **36** such as a dimple extending outwardly and laterally to act as a positive stop for locating the tube **16**. The bosses **24** are stacked together such that the apertures **32** are aligned to form the flow headers **22** to allow parallel flow of fluid such as refrigerant through the tubes **16**. The flanges **34** are also stacked together to form a slot or opening **38** to receive one end of the tubes **16**. The first end tank **12** is made of a metal material such as aluminum having a cladding on its inner and outer surfaces for brazing. The first end tank **12** is also formed as a stamping using a drawn-cup stamping process, which is conventional and known in the art.

[**0017**] The second end tank **14** may include at least one raised boss **40** extending laterally and vertically. The boss **40** acts as a solid plate baffle. The second end tank **14** includes at least one, preferably a pair of flanges **42** spaced laterally and extending axially. Each of the flanges **42** has a generally U-shaped cross-section to receive the other end of the tubes **16**. Each flange **42** may include a projection **44** such as a dimple extending outwardly and laterally to act as a positive stop for locating the tube **16**. The bosses **40** are stacked together to allow flow of fluid such as refrigerant between the laterally spaced tubes **16**. The flanges **42** are also stacked together to form a slot or opening **46** to receive the other end of the tubes **16**. The second end tank **14** is made of a metal material such as aluminum having a cladding on its inner and outer surfaces for brazing. The second end tank **14** is also formed as a stamping using a drawn-cup stamping process, which is conventional and known in the art.

[**0018**] The tubes **16** extend axially and are generally rectangular in cross-sectional shape. Each of the tubes **16** has a passageway **48** extending axially therethrough to allow a fluid such as refrigerant to pass therethrough. The tubes **16** are made of a metal material such as aluminum having a cladding on its inner and outer surfaces for brazing. The tubes **16** are formed as an extrusion using an extrusion process, which is conventional and known in the art.

[**0019**] In operation, fluid such as refrigerant from the air conditioning system enters the evaporator **10** through the fluid inlet **26** on the first mounting plate **18**. The refrigerant flows in the flow header **22** of a first pair of joined first end tanks **12** and flows through the passageway **48** in one of the tubes **16**. The refrigerant flows from the tube **16** and through a channel **49** of the first pair of joined second end tanks **14** and through the passageway **48** of the other laterally spaced tube **16**. The refrigerant flows from the tube **16** and out of the other flow header **22** in the first pair of joined end tanks **12**. The refrigerant flow repeats this U-shaped flow through each level of the evaporator **10** and exits the evaporator **10** through the fluid outlet **28** on the second mounting plate **20**. It should be appreciated that refrigerant flows though several tubes in parallel, with baffles (not shown) directing the flow. It should also be appreciated that there are may different options for circuiting refrigerant such that it goes through one face of the core first, up the other face or u-flows down the core and that baffles (not shown) may be located between joined pairs of end tanks **12,14** to direct the refrigerant flow as desired.

[**0020**] Also, a method of making the evaporator **10**, according to the present invention, is shown. The method includes the step of contacting a pair of first end tanks **12** with each other to form the flow headers **22** and contacting opposed flanges **34** with each other to form the openings **38**. The method includes the step of brazing the pair of first end tanks **12** by heating the first end tanks **12** to a predetermined temperature to melt the brazing material to braze the first end tanks **12** together. The pair of joined first end tanks **12** is then cooled to solidify the molten braze material to secure the first end tanks **12** together. The method includes the step of contacting a pair of second end tanks **14** with each other to form the channel **49** therebetween and contacting opposed flanges **42** with each other to form the openings **46**. The method includes the step of brazing the pair of second end tanks **14** by heating the second end tanks **14** to a predetermined temperature to melt the brazing material to braze the second end tanks **14** together. The pair of joined second end tanks **14** is then cooled to solidify the molten braze material to secure the second end tanks **14** together. The method includes the step of inserting one end of the tube **16** in one of the openings **38** of the first end tank **12** until the tube **16** contacts the projection **36**. The method includes the step of inserting the other end of the tube **16** in one of the openings **46** of the second end tank **14** until the tube **16** contacts the projection **44**. The method includes the step of inserting one end of another tube **16** in the other of the openings **38** of the first end tank **12** until the tube **16** contacts the projection **36**. The method includes the step of inserting the other end of the tube **16** in the other of the openings **46** of the second end tank **14** until the tube **16** contacts the projection **44**. The method includes the step of stacking the joined end tanks **12, 14** together and aligned in a stack. The method includes the step of disposing fins **30** between the tubes **16** and joining, such as by brazing, the fins **30**, tubes **16** and the stack of the joined end tanks **12,14** together. The brazing is accomplished by heating the end tanks **12,14**, tubes **16**, and fins **30** to a predetermined temperature to melt the brazing material to braze the bosses **24,40** together. The stack of joined end tanks **12,14** is then cooled to solidify the molten braze material to secure the bosses **24,40** and the tubes **16** and fins **30** together. The method includes the step of connecting the first and second mounting plates **18** and **20** to the brazed end tanks **12,14** to form the evaporator **10**. It should be appreciated that the end tanks **12,14** could be stacked and the tubes **16** and fins **30** assembled to the end tanks **12,14** and brazing the assembly together at one time to form the evaporator.

[**0021**] Referring to **FIG. 5**, another embodiment **110**, according to the present invention, is shown for the evaporator **10**. Like parts of the evaporator **10** have like reference numerals increased by one hundred (**100**). In this embodiment, the evaporator **110** may include a screen or mesh **150** stamped into the first end tank **112** in the apertures **132** for improved flow distribution through the flow headers **122**. The mesh **150** is a generally rectangular grid forming a plurality of apertures **152** having a generally rectangular shape to allow fluid to pass therethrough. The mesh **150** and apertures **152** may have any suitable shape. The evaporator **110** is made and operates similar to the evaporator **10**. It should be appreciated that the mesh **150** could be stamped into either one or both end tanks **112,114**.

[**0022**] The present invention has been described in an illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

[0023] Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

What is claimed is:

1. An evaporator comprising:

a pair of joined first end tanks;

a pair of joined second end tanks spaced from and opposing said first end tanks;

a plurality of extruded fluid carrying tubes extending between and in fluid communication with said first end tanks and said second end tanks; and

each of said first end tanks and said second end tanks comprising a stamping, each of said first end tanks having a pair of raised first bosses spaced laterally and extending outwardly therefrom, each of said first bosses including an aperture extending therethrough, and a mesh disposed in said aperture and stamped into one of said first end tanks.

2. An evaporator comprising:

a plurality of generally parallel first end tanks, pairs of said first end tanks being joined together in a face-to-face relationship, the pairs of said first end tanks being joined together and aligned in a stack;

a plurality of generally parallel second end tanks, pairs of said second end tanks, pairs of said second end tanks being joined together in a face-to-face relationship, the pairs of said second end tanks being joined together and aligned in a stack;

a plurality of extruded fluid carrying tubes, a pair of said tubes being spaced laterally and extending between and in fluid communication with a joined pair of said first end tanks and said second end tanks;

a plurality of fins attached to an exterior of said tubes; and

each of the joined pair of said first end tanks and said second end tanks comprising stampings, each of the joined pair of said first end tanks having a pair of raised bosses spaced laterally and extending outwardly therefrom, and a mesh disposed over said aperture and stamped into said first end tanks.

3. A method of making an evaporator comprising the steps of:

providing a plurality of generally parallel first end tanks formed as stampings, pairs of the first end tanks being joined together in a face-to-face relationship, the pairs of the first end tanks being joined together and aligned in a stack;

providing a plurality of generally parallel second end tanks formed as stampings, pairs of the second end tanks being joined together in a face-to-face relationship, the pairs of the second end tanks being joined together and aligned in a stack;

providing a plurality of extruded fluid carrying tubes extending between and in fluid communication with opposed pairs of the first end tanks and the second end tanks;

providing a plurality of fins to be attached to an exterior of the tubes and disposing the fins between the tubes; and

joining the fins and pairs of first end tanks and second end tanks together to form the evaporator.

4. A method as set forth in claim 3 wherein said step of providing the plurality of generally parallel first end tanks and second end tanks includes the step of forming a flange extending axially to form an opening.

5. A method as set forth in claim 4 wherein said step of providing the plurality of generally parallel first end tanks and second end tanks includes the step of forming a projection extending into the opening.

6. A method as set forth in claim 4 including the step of inserting an end of the tubes into the opening and locating the end of the tubes relative to the opening via the projection.

7. A method as set forth in claim 3 wherein said step of joining comprises brazing the first end tanks and second end tanks and tubes and fins together.

8. A method of making an evaporator comprising the steps of:

stamping a plurality of generally parallel first end tanks and forming a flange extending axially to form an opening;

stacking pairs of the first end tanks together in a face-to-face relationship, the pairs of the first end tanks being aligned in a stack;

stamping a plurality of generally parallel second end tanks and forming a flange extending axially to form an opening;

stacking pairs of the second end tanks together in a face-to-face relationship, the pairs of the second end tanks being aligned in a stack;

providing a plurality of extruded fluid carrying tubes;

inserting an end of the tubes into the opening and extending the tubes between and in fluid communication with opposed pairs of the first end tanks and the second end tanks;

providing a plurality of fins and disposing the fins between the tubes; and

brazing the first end tanks and second end tanks and tubes and fins together to form the evaporator.

9. A method as set forth in claim 8 including the step of forming a projection extending into the opening.

10. A method as set forth in claim 9 including the step of locating the end of the tubes relative to the opening via the projection.

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