Sept. 8, 1964 A. O. TADEWALD 3,147,800

SERPENTINED HEAT EXCHANGER

Filed Dec. 29, 1960 3 Sheets-Sheet 1

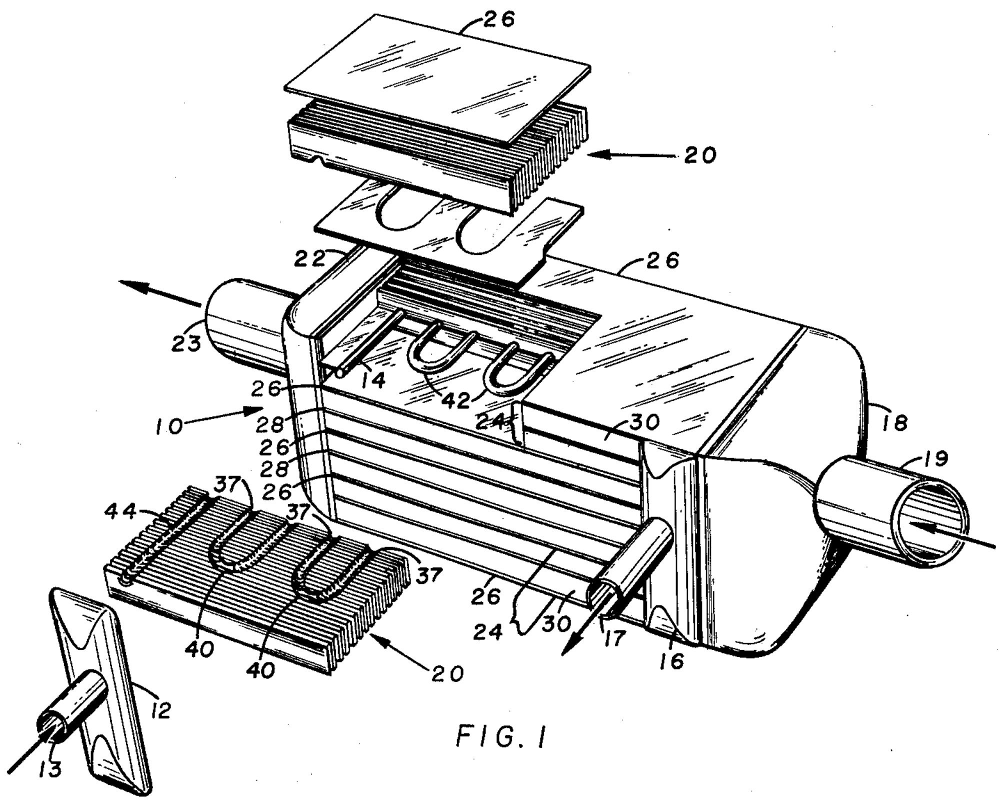

FIG. 1

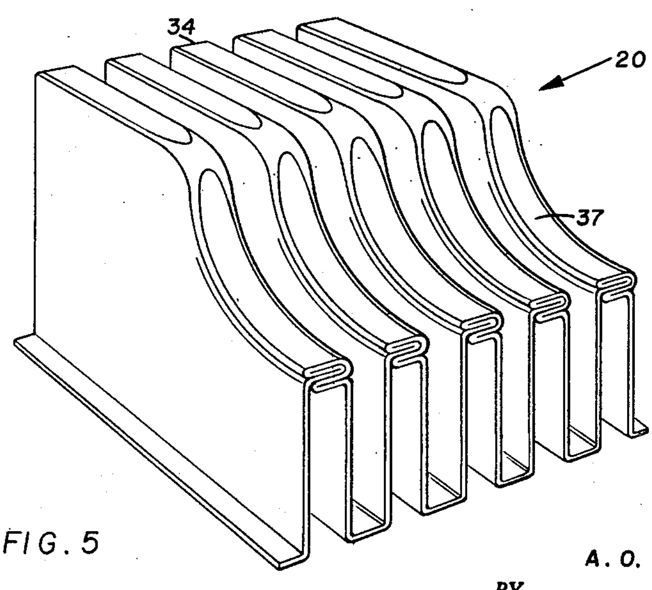

FIG. 5

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3 Sheets-Sheet 2

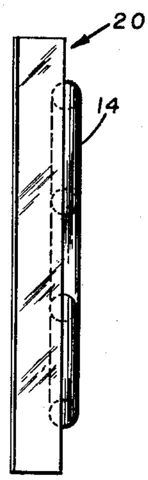

FIG. 3

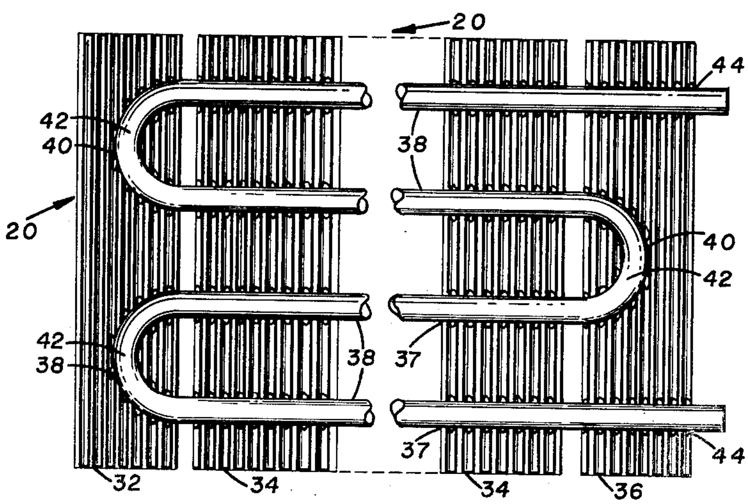

FIG. 2

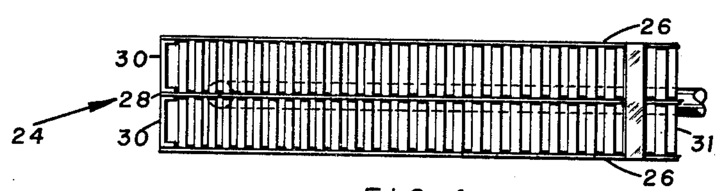

FIG. 4

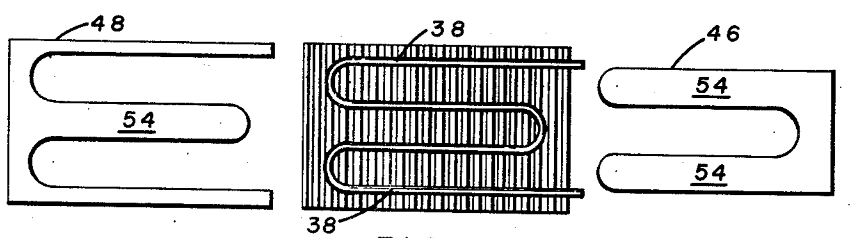

FIG. 6

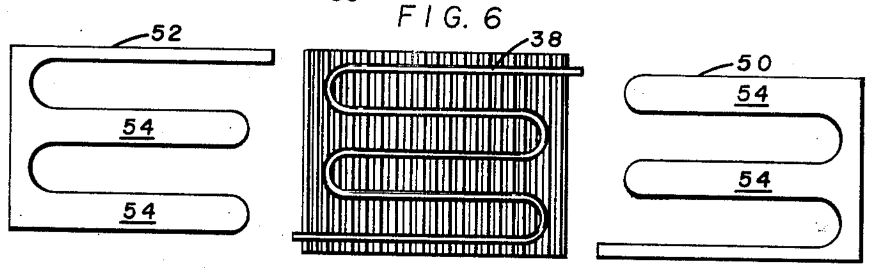

FIG. 7

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SERPENTINED HEAT EXCHANGER

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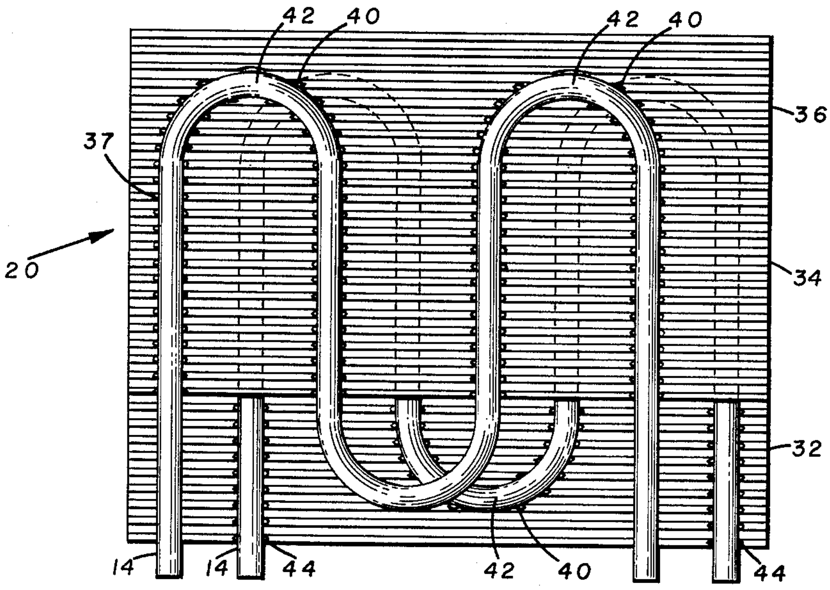

FIG. 8

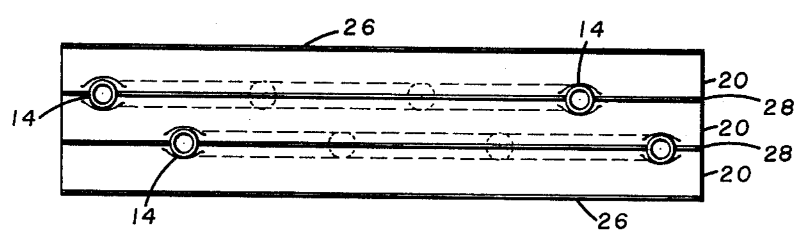

FIG. 9

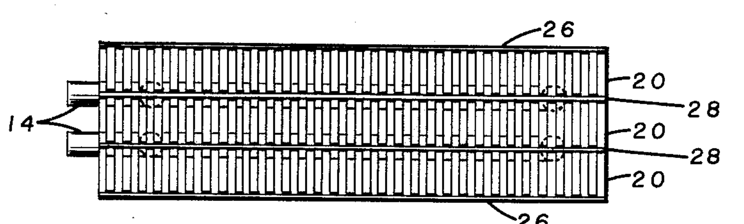

FIG. 10

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SERPENTINED HEAT EXCHANGER

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Filed Dec. 29, 1960, Ser. No. 79,366
7 Claims. (Cl. 165—164)

This invention relates generally to heat exchange units and more specifically to a multi-pass heat exchanger which employs serpentined tubes for at least one pass with the U-bends of said serpentined heat exchange tubes being internally located and having fin members in operative relationship therewith.

It is an object of this invention to provide a heat exchanger with internal U-bends which will withstand high operating pressures.

Another object of the invention is to provide a brazed heat exchanger with internally finned heat exchange tubes which increase the efficiency of the heat exchanger and will withstand high operating pressures.

It is a third object of this invention to provide a brazed aluminum heat exchanger which employs internal serpentined heat exchange tubes to increase the strength and efficiency of the heat exchanger.

A still further object of the invention is to provide an internally tubed brazed heat exchanger in which a continuous corrugated fin is provide with recesses to accommodate the tube member.

A fifth object of the invention is to provide a heat exchanger with serpentined heat exchange tubes which lie in recesses formed in a continuous corrugated fin member.

Another object of the invention is to provide a brazed aluminum heat exchanger in which a continuous corrugated fin element, with tube receiving recesses formed therein is employed to accommodate a serpentined heat exchange tube thereby forming a heat exchanger which is readily manufactured, efficient in operation, and will withstand high operating pressures.

Other objects and advantages of my invention will become apparent as the specification proceeds to describe the invention with reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of a typical heat exchanger with a portion broken out to show the general features of my invention;

FIGURE 2 is a top view of one continuous corrugated fin member with a serpentined heat exchange tube therein;

FIGURE 3 is a side view of FIGURE 2;

FIGURE 4 is an end view showing two continuous corrugated fin members spaced one atop the other with a serpentined heat exchange tube therebetween;

FIGURE 5 is a perspective view of a portion of the tube receiving recesses formed in the fin member to receive the serpentined tube member;

FIGURES 6 and 7 are views similar to FIGURE 2 showing the location and shape of the parting sheets as applied to heat exchangers with different entering and exiting tube members.

FIGURE 8 is a top view of a modification of the heat exchanger shown in FIGURES 1–7;

FIGURE 9 is an end view of the heat exchanger of FIGURE 8, and

FIGURE 10 is a side view of the heat exchanger shown in FIGURE 8.

Referring now to FIGURE 1, a typical heat exchanger 10 is shown incorporating my new and novel arrangement. The invention is shown as applied to a two pass heat exchanger but obviously heat exchangers of many passes and header arrangements can be employed within the scope of the invention.

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Preferably, a cooling fluid enters header 12 through inlet 13 and passes through serpentined heat exchange tube 14 and is collected in header 16 and discharged through outlet 17. Hot gas, preferably, enters header 18 through inlet 19 and passes counterflow to the cooling fluid through plate type corrugated heat exchange fins 20 to outlet header 22 from whence it is discharged through outlet 23.

Corrugated fin members 20 of the plate type and serpentined tubes 14 are constructed from aluminum, preferably, because aluminum provides a non-corrosive and light weight heat exchanger. Obviously though, stainless steel fin members or tubes could be used. If higher tensile strength is necessary aluminum alloys also could be employed. Other materials and combinations thereof can be employed, if desired.

In the preferred form, heat exchanger 10 is constructed of a series of heat exchange sections 24 brazed or welded together. Parting sheets 26 are employed between each heat exchange section 24 to form a unitary structure. These parting sheets 26 may be brazed or welded to the respective heat exchange section.

Each heat exchange section 24 basically consists of two corrugated fin members 20, a serpentined heat exchange tube 14 between the fins 20, and a parting sheet 28 between the fins 20 brazed or welded to the tubes 14 and the fin members 20. Channel sections 30 and block off bars 31 are provided to prevent leakage of gas to the outside and provide structural strength to the heat exchanger.

Each fin member 20 has at least three sections, namely 32, 34, and 36. Additional sections 34 may be employed depending on the width or length of heat exchanger desired. The particular length and width of sections 32 and 36 are not considered part of the invention.

Each fin member section 34 has a plurality of recesses 37 formed therein to accommodate half the diameter of the straight portion 38 of the serpentined heat exchange tube 14. These recesses are formed in the manner shown and described in my Patent No. 2,820,617, filed November 7, 1955, and issued January 21, 1958.

Fin member sections 32 and 36 are formed with U-bend recesses 40 to accommodate the U-bend sections 42 of serpentined heat exchange tube 14. The portion of the sections 32 and 36 where the serpentined tubes 14 are headered are formed with recesses 44 like those of fin member section 34.

In construction, a parting sheet 26 is first put down. Then a corrugated fin member consisting of sections 32, 34, and 36 is laid on the parting sheet with the recesses facing upwardly. A serpentined heat exchange tube 14 is placed on the fin member 20 with the straight portions 38 of serpentined tube in the recesses 37 and 44 and the U-bends in the recesses 40. Parting sheets 46 and 48 or 50 and 52 are then placed on the fin members 20 with the projections 54 extending between the U-portion of the serpentined tube. A second fin member 20 is then placed upon the tube 14 and the first fin member 20, so that the fin portions of the first fin member and the second fin member surround and engage tube 14. A second parting sheet 26 is placed on top of the second fin member 20 and channel sections 30 are placed adjacent the end of the corrugated fin member 20. The whole assembly is then temporarily held together by any suitable means such as clamping and is brazed or welded by any suitable process.

In actual practice, the heat exchanger 10 will be built up to the appropriate length, width, and depth and brazed as unit instead of individual brazing of heat exchange sections 24 and then the appropriate headers such as 12, 16, 18, and 22 are brazed on.

Particular notice should be taken of FIGURES 6 and

7 which show two forms of parting sheets which are used with my heat exchanger depending on whether the serpentined tubes **14** enter and exit on the same side of the heat exchanger or on opposite sides of the heat exchanger.

FIGURE 6 shows the parting sheets **46** and **48** which are used between fin members **20** when the serpentined tube **14** enters and exits on the same side of the heat exchanger **10**.

FIGURE 7 shows the parting sheets **50** and **52** which are employed when the serpentined tubes **14** enter one side of the heat exchanger and exit from the other side.

Looking now to the modification of FIGURES 8–10, the heat exchanger **10** is shown composed of a series of corrugated fins **20** stacked one upon the other with serpentined heat exchange tubes **14** disposed between each corrugated fin member. The fin member, as in the embodiment of FIGURES 1–7, has at least three sections **32**, **34**, and **36** with recesses **37**, **40**, and **44** therein to accommodate the serpentined tubes **14**. The recesses are so formed so as to surround and engage the tube **14**. Parting sheets **28** like those of FIGURES 6 and 7 are employed between the fin members **20** and parting sheets **26** are employed on the top and bottom of the heat exchange section.

In FIGURE 8, the section **32** of the top heat exchange section **20** has been removed to show the offset relationship of the serpentined heat exchange tubes. As shown in FIGURES 8 and 9 the heat exchange tubes between adjacent fin members **20** are offset in relation to one another. This is necessary due to manufacturing reasons since the forming of recesses on both sides of the heat exchange members with one recess on top of the other would weaken the fin member and be very difficult to form.

For the sake of disclosure only three fin members **20** are shown but obviously the number of fin members and tubes therebetween is dependent only on the heat exchange function of the particular heat exchanger manufactured.

It is obvious that the above described invention has many advantages not present in previous heat exchangers. Previous to my invention, heat exchangers which employed serpentined heat exchange tubes had the U-bends extending outwardly from the heat exchanger where obviously this section of the tube was not useful for the purpose intended. Further, in brazing a heat exchanger this surface was lost as a brazing surface which inherently lowered the pressure at which the heat exchanger could operate. I have not only increased the efficiency of the heat exchanger by internally locating the complete serpentined heat exchange tube but have provided a fin construction which allows complete and efficient use of the complete serpentined heat exchange tube. I have also provided a heat exchanger construction which when brazed will withstand pressures up to 1800 p.s.i. without rupture. Further, as herein set forth, I have provided a heat exchanger which is readily assembled and can be made to perform numerous heat exchange functions by merely changing the header construction or the number of passes or both..

While the apparatus disclosed and described herein constitutes preferred forms of the invention, yet it will be understood that the apparatus is capable of alteration without departing from the spirit of the invention, and that all modifications that fall within the scope of the appended claims are intended to be included herein.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A heat exchanger comprising: a first inlet header and a first outlet header, a plurality of pairs of corrugated plate type fin members extending between said first inlet header and said first outlet header and forming a passage for a first heat exchange fluid, said fin members of each pair being superimposed and co-extensive with the other fin member of the pair, means forming a plurality of recesses in said fin members, said recesses being located to form a passage between said fin members in each pair to accommodate a serpentined heat exchange tube, a serpentined heat exchange tube located in said recesses with the U-bends of said heat exchange tube being confined within said fin members, and means communicating with said heat exchange tube to provide for passage heat exchange fluid into and out of said heat exchange tube.

2. The structure of claim 1 wherein a parting sheet is located between said fin members in each pair, said parting sheet being in at least two sections with one section abutting one side of said heat exchange tube and the other section abutting the other side of said heat exchange tube.

3. The structure of claim 2 wherein a one piece parting sheet is provided between each pair of said fin members.

4. A heat exchanger comprising a first supply header, a first discharge header, means forming a fluid passage extending between said headers for a first heat exchange fluid, a plurality of pairs of plate type fin members in said fluid passage extending between said first supply header and first discharge header, a second supply header and a second discharge header, a plurality of serpentined heat exchange tubes each communicating at one end to said second supply header and connected at the other end to said second discharge header, and means locating one of said serpentined heat exchange tubes between and substantially within each pair of said fin members to internally locate the U-bends of said heat exchange tube whereby said U-bends are available as a heat transfer surface to increase the efficient use of said serpentined heat exchange tube.

5. A heat exchanger comprising a first supply header, a first discharge header, means forming a fluid passage extending between said headers for a first heat exchange fluid, a pair of plate type fin members in said fluid passage extending between said first supply header and first discharge header, a second supply header and a second discharge header, at least one serpentined heat exchange tube communicating at one end to said second supply header and connected at the other end to said second discharge header, means locating said serpentined heat exchange tube between and substantially within said fin members to internally locate the U-bends of said heat exchange tube whereby said U-bends are available as a heat transfer surface to increase the efficient use of said serpentined heat exchange tube, a parting sheet located between said fin members in said pair, said parting sheet being in two sections with one section abutting one side of said heat exchange tube and the other section abutting the other side of said heat exchange tube.

6. A heat exchanger comprising a first supply header, a first discharge header, means forming a fluid passage extending between said headers for a first heat exchange fluid, a plate type fin structure in said fluid passage extending between said first supply header and first discharge header, a second supply header and a second discharge header, at least one serpentined heat exchange tube communicating at one end to said second supply header and connected at the other end to said second discharge header, means locating said serpentined heat exchange tube within said fin structure and wholly within said heat exchanger to internally locate the U-bends of said heat exchange tube whereby said U-bends are available as a heat transfer surface to increase the efficient use of said serpentined heat exchange tube, said fin structure being comprised of at least three sections, two of said sections having recesses formed therein which accommodate the U-bend portions of said heat exchange tube, and the third section having recesses therein to accommodate the straight portions of said serpentined heat exchange tube.

7. A heat exchanger comprising a first supply header, a first discharge header, means forming a fluid passage extending between said headers for a first heat exchange fluid, a plurality of plate type fin members in said fluid

passage extending between said first supply header and first discharge header, a second supply header and a second discharge header, a plurality of serpentined heat exchange tubes each communicating at one end to said second supply header and connected at the other end to said second discharge header, means locating each one of said serpentined heat exchange tubes between and substantially within pairs of said fin members to internally locate the U-bends of said heat exchange tubes whereby said U-bends are available as a heat transfer surface to increase the efficient use of said serpentined heat exchange tube, and one of said heat exchange tubes being offset from the heat exchange tube between the next adjacent fin members.

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