

Feb. 23, 1960

V. PULSIFER HEAT EXCHANGER

2,926,003

Filed May 4, 1955

2 Sheets-Sheet 1

FIG. 1.

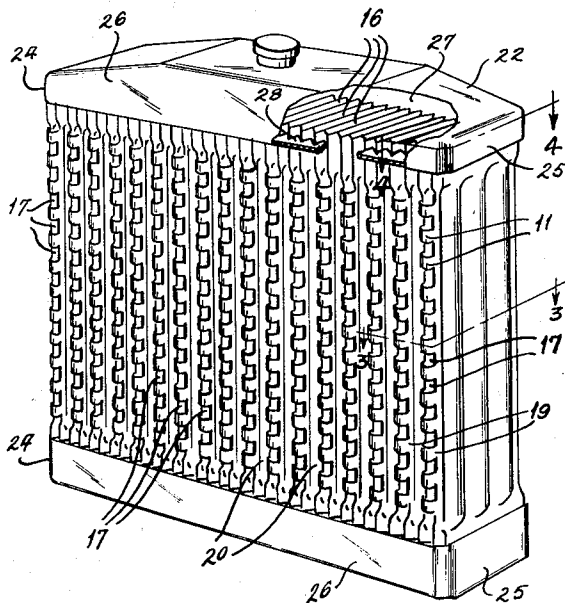


FIG. 3.

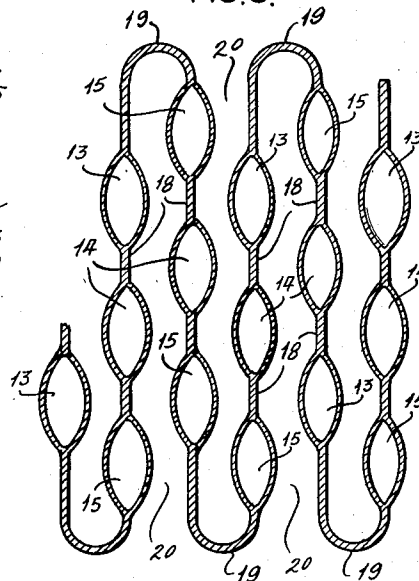
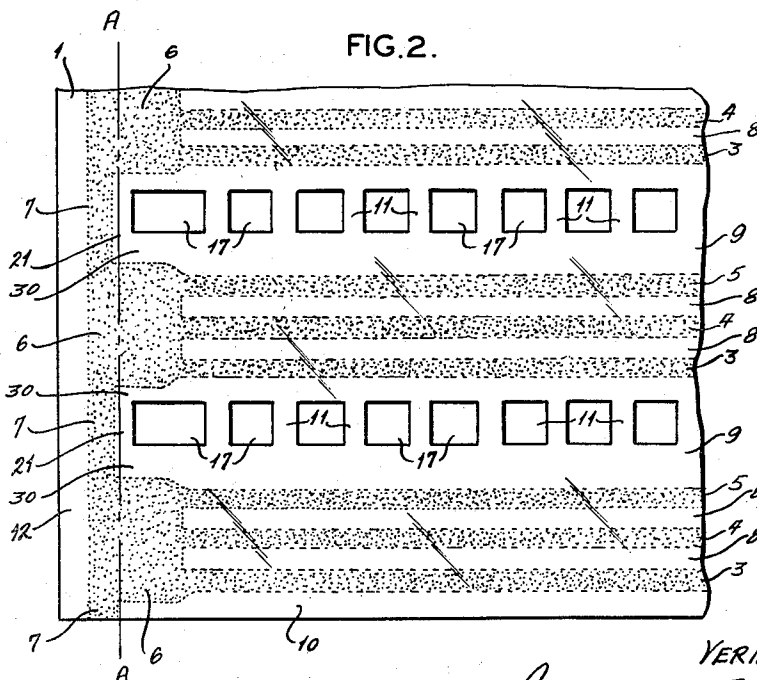


FIG. 2.



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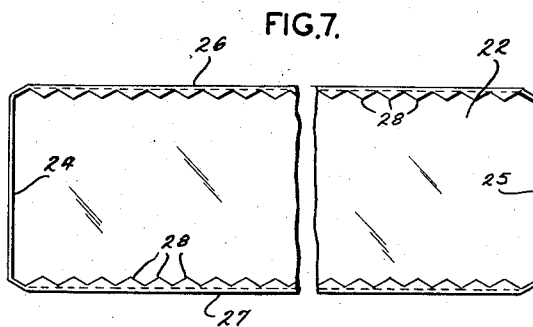
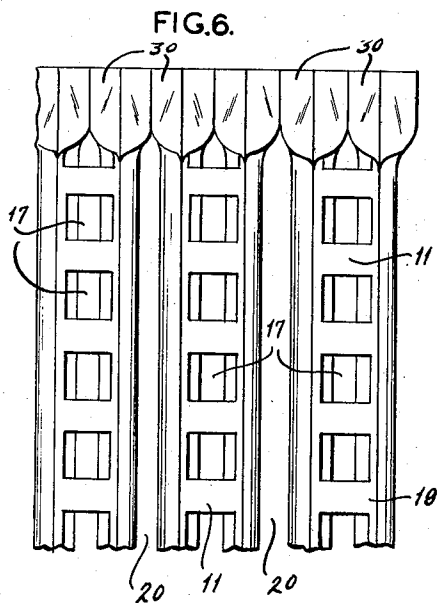
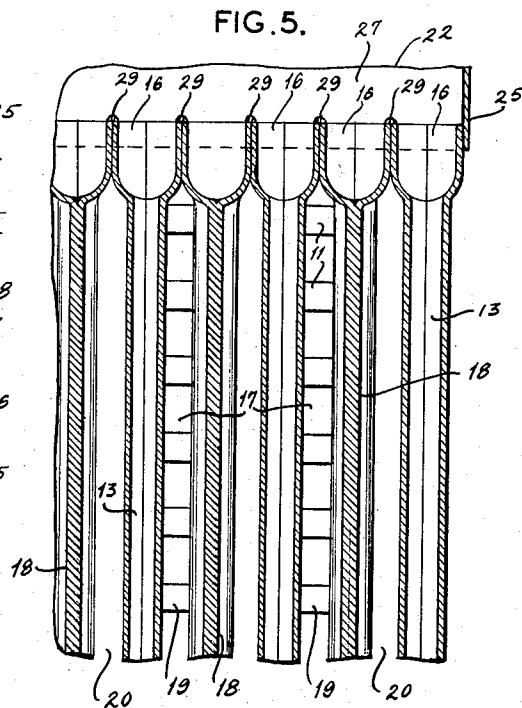
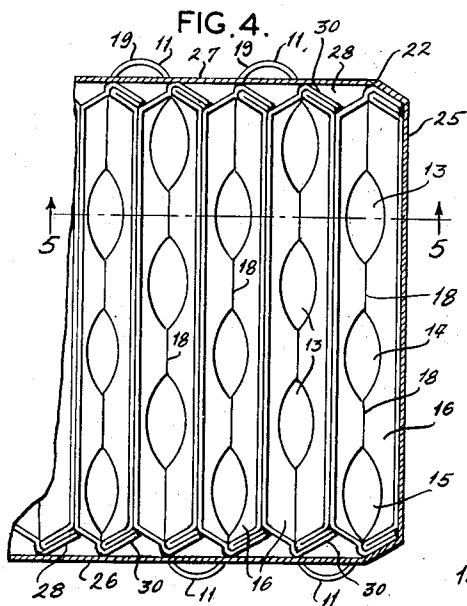
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V. PULSIFER
HEAT EXCHANGER

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2 Sheets-Sheet 2



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2,926,003

HEAT EXCHANGER

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Application May 4, 1955, Serial No. 505,883

4 Claims. (Cl. 257—130)

This invention relates generally to heat exchangers of the multiple parallel tube type as exemplified by automobile radiators, and represents an improvement, in some respects, over the heat exchanger disclosed in the copending application of John D. Wilkins, Serial No. 495,542, filed March 21, 1955.

In the aforesaid Wilkins application, there is disclosed a heat exchanger of the character aforesaid, in which the heat dissipating core is formed of a pressure unified plate which is zig-zag folded to provide an aligned series of panels, each containing a plurality of parallel tubes with intervening webs, and wherein the folds at opposite edges of each panel are perforated to provide for air circulation transversely of the panels. The structure shown in the Wilkins application necessitated the provision of some sort of a fluid-tight joint, such as a soldered joint, about the periphery of each individual tube where it is connected with an appropriate header. As the individual tubes are quite small, such a soldering operation is tedious, time consuming, and costly. Consequently, it is one of the objects of the present invention to eliminate much of the tedium in the provision of a fluid-tight joint between such a core and the headers therefor.

Moreover, in the aforesaid Wilkins application, the tubes extending through the respective aligned panels were symmetrically arranged within the panel, and the various tubes were aligned with corresponding tubes in other panels. Since, in order to efficiently dissipate heat from the fluid circulating through the tubes, it is necessary to provide an air circulating space between successive panels, the arrangement of the tubes in alignment, as shown in said Wilkins application, resulted in a transverse air path wherein there were successive constrictions at the regions where aligned tubes in adjacent panels approached each other. It is therefore a further object of the present invention to provide a core of the character aforesaid wherein the transverse air passageway between adjacent panels is of more uniform cross-section.

These objects of the invention are accomplished by providing a pressure unified plate from two component sheets with a pattern of stop-weld material intervening, as described in said Wilkins application, which plate is thereafter zig-zag folded to provide a series of aligned tube panels, but characterized by the feature that the pattern of stop-weld material which delineates the location of the tubes within the panels is joined at the ends by areas of stop-weld material which interconnect all tubes of a given panel, and which, upon distention, provides an open chamber which serves as a subheader for the tubes of that panel; and characterized by the further feature that the folds which integrally interconnect the successive panels are made eccentrically with respect to the web being folded, so that, while successive panels are in alignment, the tubes of successive panels are not in alignment with each other. More specifically, the tubes of a given panel are aligned with the webs which intervene tubes of the panels on either side thereof.

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By the provision of the subheader, as aforesaid, for each panel, the fluid-tight connection between the tubes of that panel and an appropriate header is facilitated because a fluid-tight joint does not have to be made about each tube, but rather is made about the subheader alone. While such a joint may be longer than the cumulative lengths of the several joints which would be necessary about individual tubes, its larger magnitude reduces the tedium required, and when the successive subheaders are abutted, a single joint between them serves the dual function of sealing each.

One embodiment of the invention, as exemplified by an automobile radiator core, is illustrated in the accompanying drawings, in which:

Figure 1 is a perspective view of an automobile radiator constructed in accordance with the present invention;

Figure 2 is a partial plan view of a pressure unified plate from which the core of the radiator shown in Figure 1 may be made;

Figure 3 is a sectional view taken along line 3—3 of Figure 1;

Figure 4 is a sectional view taken along line 4—4 of Figure 1;

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

Figure 6 is a view in front elevation of a part of the core of the radiator shown in Figure 1; and

Figure 7 is a bottom plan view of the upper header forming a part of the radiator shown in Figure 1.

Referring first to Figure 2 of the drawings, there is illustrated a plan view of part of a plate 1 which results from the pressure unification of two sheets of metal with an intervening pattern of stop-weld material indicated by the stippled area. The pattern of stop-weld material includes a series of three strips 3, 4, and 5, which delineate the tube forming areas within the plate 1. The pattern of strips 3, 4, and 5 is repeated within the plate 1, there being as many repetitions as it is desired to form panels in the core to be produced. Across one end of each series of strips 3, 4, and 5, there is a substantially square pattern of stop-weld material 6 which interconnects with each of the strips 3, 4, and 5. The pattern 6 is likewise repeated across the plate 1 with each repetition of the strips 3, 4, and 5, and the several patterns 6 are interconnected by strips 7, one of which extends to the margin of the plate 1, and is there accessible for the reception of an inflation fluid under the pressure of which the strips 3, 4, and 5 are distended to form tubes, and the areas 6 are distended to form open chambers in connection with the tubes formed at the associated strips 3, 4, and 5. Between strips 3 and 4, as well as between strips 4 and 5, there is an elongated area 8 which was unprotected by stop-weld material, and hence in the pressure unification operation, the two component sheets of plate 1 became bonded at these areas. Similarly, between strip 5 of one group and strip 3 of the next group, there is an elongated area 9 wider than areas 8 which, being unprotected by the stop-weld material, became bonded during the pressure unification operation. Along the outer margin of the plate 1, an elongated bonded area 10 likewise exists.

The bonded areas 8 and 9 provide webs which not only connect the several tubes into an integral structure, but also serve as heat dissipating surfaces, as in the aforesaid Wilkins application. At the margin of plate 1, outwardly of the stop-weld material 6 and 7, a bonded strip 12 is also provided. At the side of the plate opposite that shown in Figure 2, the same pattern of areas 6 is reproduced at the other ends of strips 3, 4, and 5, except that the interconnecting strips 7 need not be there provided, or the strip 7 which extends to the margin of the plate need not be provided unless it is desired to in-

plate from two separate points of entry. In the bonded areas 9, a series of openings 17 are cut, punched, or extruded in any desired manner, leaving intervening bridges 11 between them. In accordance with the present invention, the series of openings 17 are formed eccentrically within the bonded areas 9 in order that when the plate is zig-zag folded along the center lines of said openings, there will be more residual metal at one side of the openings than at the other, and the present invention contemplates that the difference be such as to amount to one-half the distance between the center lines of strips 3 and 4 so that when zig-zag folded as aforesaid, strip 5 (or the tube delineated thereby) of the lower group shown in Figure 2 will be aligned with the web 8 between strips 3 and 4 of the next group.

Upon inflation of the plate described, the several strip areas 3, 4, and 5 are distended to form tubes 13, 14, and 15, as shown clearly in Figures 3 and 5, and the several areas 6 are distended to form open chambers 16, as shown clearly in Figures 4 and 5, it being understood that the distention may be accomplished either before or after plate 1 is zig-zag folded. After such distention, plate 1, or the zig-zag folded structure resulting therefrom, is cut off along line A—A of Figure 2 so as to leave the chambers, delineated by stop-weld material 6, open at one margin thereof, which will become the top or bottom, as the case may be, in the completed core.

The elongated areas 8 of the plate, which were unprotected by stop-weld material, become webs 18 in the distended structure intervening the tubes 13—14 and 14—15, respectively. Likewise, the areas 9 of the plate 1 which were unprotected by stop-weld material become webs 19 in the distended structure intervening the outmost tube 15 of one panel, and the outmost tube 13 of the adjacent panel of the zig-zag folded structure. The webs 19 are of greater width than the webs 18, and in the zig-zag folding operation, the webs 19 are folded sufficiently off-center, as shown clearly in Figure 3, that the tubes in one panel are aligned with the webs in the adjacent panels on each side thereof. Such alignment of tubes in alternate panels with webs of the intervening panels provides a sinuous transverse air passageway 20 between the respective panels, and the air passageway is of substantially uniform cross-section as it passes by the several tubes.

The eccentricity of openings 17 with respect to area 9 of plate 1 is coordinated with the spacing of tubes 13, 14, and 15 in the respective panels so that when the tubes of alternate panels are aligned with webs of intervening panels as above described, the openings 17 will be situated at the bight of the zig-zag folds at the leading and trailing sides of the completed structure, thereby providing for access of air to and from the spaces 20 between the tube panels.

In preparing the zig-zag folded structure for assembly with an appropriate header, the portions 21 of the bonded areas 9 are severed as by cutting away the residual metal between the nearest opening 17 and line A—A along which the plate has previously been trimmed. This leaves a relatively short bonded area 30 on the outside at each end of each open chamber 16 which is then folded back, as shown clearly in Figure 4, for convenience in conforming the bottom of a header member to interfit therewith. Such a header member may be provided in any convenient form, such as the top header 22 and bottom header 23 shown in Figure 1. As illustrated in the drawings, the header members are tanks wherein the bottom of header 22 and the top of header 23 are cut away to an internal configuration which conforms with the exterior configuration of the aligned series of open chambers 16, as shown in Figures 4 and 7. In the embodiment shown, where the open chambers 16 are abutted together so that the assembly has a saw-tooth configuration in plan view, the configuration of the bottom of header 22 (as well as the configuration of the

top of header 23) will be as shown in Figure 7. Such a header has end walls 24 and 25 and side walls 26 and 27, and the bottom wall thereof is cut away to leave only a series of triangular shaped tabs 28 extending inwardly from the side walls 26 and 27. The tabs 28 are proportioned both angularly and dimensionally so that their internal contour corresponds with the external contour of the series of abutted subheaders 16. Prior to the assembly of the headers 22 and 23 with the zig-zag folded core member, a fluid-tight seal, such as a line of solder, may be run along the edges of the abutting walls of the subheaders 16, as indicated by the numeral 29 in Figure 5, and then, after the header is fitted over the core, a similar seal may be formed between the edges of triangular tabs 28 and the adjacent end walls of the subheaders 16. This line of solder may be applied from the exterior of the structure. Similarly, a line of solder may be run along the joint between end walls 24 and 25 of the header and the adjacent side walls of the outermost subheaders 16.

From the foregoing description, those skilled in the art will readily understand that the soldered joints, or other sealing means necessary to form a fluid-tight connection between the header and the tubes is greatly facilitated by virtue of the fact that the lines of solder are much easier to accomplish than would be necessary with a soldered joint about the periphery of each tube. Moreover, the arrangement of the tubes in the respective panels so that the tubes of alternate panels are aligned with the webs of intervening panels improves the continuity and efficiency of heat transfer from the fluid within the tubes to the fluid, such as air, circulating past the exterior of the tubes and the intervening webs, through all of which heat is dissipated.

While the invention has been disclosed with particular reference to an automobile radiator construction, it will be understood that the heat exchange member is applicable to other situations, and that whereas water has been referred to as the fluid circulating through the several tubes, and air as the fluid circulating between the panels, it will be understood that other media may be employed in either or both of such circulation paths. Since it is apparent that those skilled in the art will readily adapt and apply the heat exchange device of the present invention in other situations, and in different forms, it is to be distinctly understood that the invention is not limited to the precise form shown in the accompanying drawings and herein described in detail. On the contrary, such modifications and variations as do not depart from the spirit of the invention are, although not specifically described herein, contemplated by and within the scope of the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a heat exchanger of the multiple tube type formed from a pressure unified plate having internal parallel tubes each sealed off from its neighbors by pressure unified areas at each longitudinal side thereof, and said plate being zig-zag folded to provide an aligned series of integrally connected spaced tube panels each containing a plurality of tubes, the improvement which comprises, each of said tube panels having at the end thereof an open chamber integral therewith and internally communicating with all tubes in that panel, the adjacent open chamber portions being abutted together, and a header having a wall internally proportioned and configured to substantially match the external contour of the series of aligned and abutted open chamber portions, said header being connected to said open chamber portions by a fluid-tight joint.

2. In a heat exchanger of the multiple tube type formed from a pressure unified plate having internal parallel tubes each sealed off from its neighbors by pressure unified areas at each longitudinal side thereof, and said plate being zig-zag folded to provide an aligned

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series of integrally connected spaced tube panels each containing a plurality of tubes, the improvement which comprises, each of said tube panels having at the end thereof an open chamber integral therewith and internally communicating with all tubes in that panel, the adjacent open chamber portions being abutted together and connected by a fluid-tight joint.

3. In a heat exchanger of the multiple tube type formed from a pressure unified plate having internal parallel tubes arranged in groups, each tube being separated from its neighbors by a flat web, each of said groups being separated from adjacent groups by a folded web extending substantially parallel with said tubes, and each group having an inlet and outlet interconnection, said folded webs being ventilated and alternately directed to provide a zig-zag folded aligned series of spaced tube panels each containing one of said groups of tubes, the improvement which comprises ventilation openings in the group-separating folded webs offset to one side of the web, and the zig-zag folds being made along the line of the openings so that the openings are centered in the fold, whereby the tubes in one panel are staggered with respect to the tubes in the panels on either side thereof to provide a tortuous external passage between panels.

4. In a heat exchanger of the multiple tube type

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formed from a pressure unified plate having internal parallel tubes each sealed off from its neighbors by pressure unified areas at each longitudinal side thereof, and said plate being zig-zag folded to provide an aligned series of integrally connected spaced tube panels each containing a plurality of tubes, the improvement which comprises, each of said tube panels having at the end thereof an open chamber integral therewith and internally communicating with all tubes in that panel, the adjacent open chamber portions being abutted together and connected by a fluid-tight joint, said zig-zag folds being located in said pressure unified areas between neighboring tubes of different panels, and said zig-zag folded pressure unified areas having ventilations therethrough.

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