

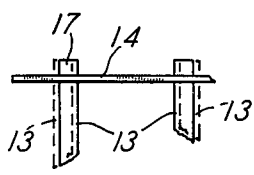
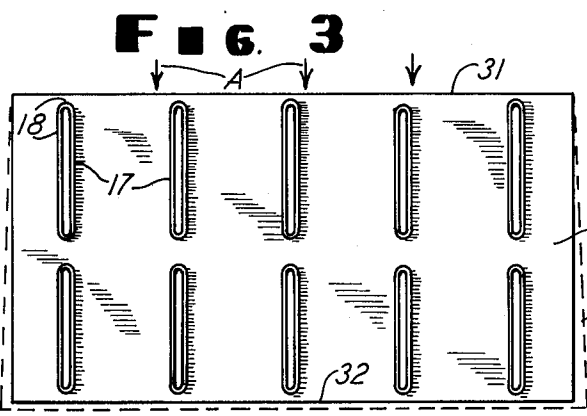
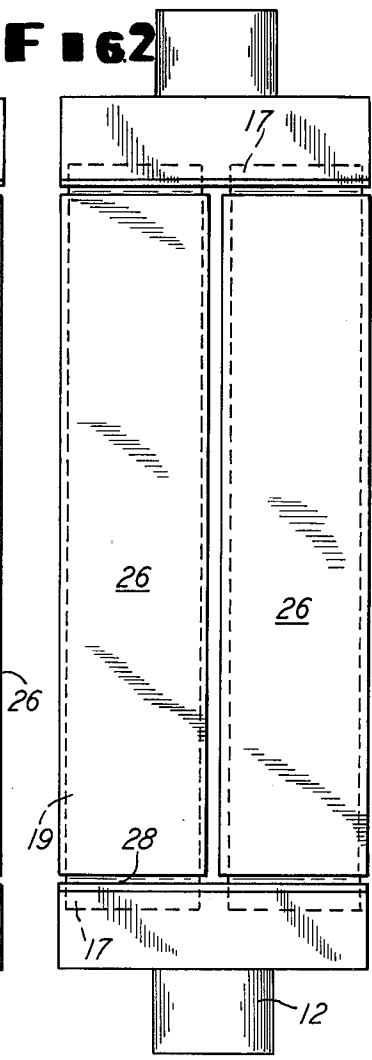
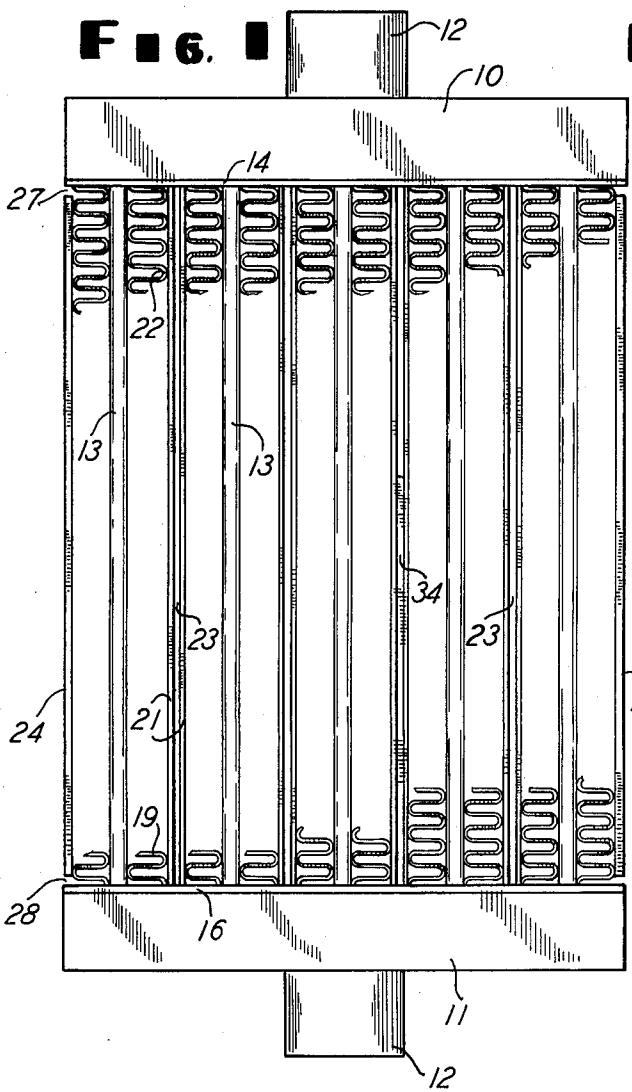
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HEAT EXCHANGER WITH INDEPENDENTLY MOUNTED TUBES AND FINS

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HEAT EXCHANGER WITH INDEPENDENTLY MOUNTED TUBES AND FINS

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This invention relates to a heat exchanger and a method of making same.

This particular invention is concerned with the problem of thermal stresses, which are developed in a heat exchanger due to the exchanger being subjected to different temperatures or rapidly changing temperatures. Thus, in a heat exchanger, such as an automobile radiator, for instance, it is possible to have a variety of temperature conditions that can create thermal stresses of various magnitudes and directions sufficient to cause failure of the radiator. Alternating temperatures in the radiator, as caused by changes in heat load, various ambient conditions, and varying flows in the cooling mediums, create these thermal stresses.

Consider, for example, the startup condition in the cooling system for an internal combustion engine of an automobile in ambient air temperature of below zero. The heat exchanger in this case, of course, will be the radiator or oil cooler, and the thermostat in the system will prevent coolant or lubricant from flowing into the exchanger until the liquid is of sufficiently high temperature to open the thermostat sensing element. In the case of the automobile radiator, it is possible to duct water at 180 degrees F. into the radiator immediately after the thermostat opens. Thermal stresses are immediately set up in the radiator, as the tubes, tanks, and headers of the radiator rapidly approach the temperature of the water, which is flowing therethrough. However, the air fins of the radiator will remain closer to the ambient air temperature, and these common conditions could provide a temperature difference of 200 degrees F. within the radiator. Thus, the radiator part, subjected to the high temperature, will of course tend to expand, while the radiator part, subjected to the low temperature, will tend to contract, and there will therefore be thermal stresses established and resultant failure can ensue. This is a particular problem and of particular concern where these conditions are cyclically repeated so that the radiator parts fail by fatigue, due to the alternating condition and the repetition thereof.

The radiator header under the conditions described could, for instance, be exposed to the higher temperature, while the radiator fins are exposed to the lower temperature so that the header tends to expand within its own plane, while the fins resist the expansion as they, in fact, tend to contract. This condition can cause failure in the area of the tube and header joints, and sometimes the bond at the joint is sheared or the tube wall itself fractures.

A broad object of this invention is to provide a heat exchanger and a method of making same so that the aforementioned problems will be avoided with respect to thermal stresses.

Still a further object of this invention is to provide a heat exchanger which will withstand temperature differences even greater than those presently withstood by heat exchangers made according to conventional practices, and with only conventional materials.

Still another object of this invention is to provide a heat exchanger which can be subjected to different temperatures even within the liquid flowing therethrough, or the other one medium flowing therethrough, but which will nevertheless avoid the undesirable buildup of thermal

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stresses caused by the temperature differences within either one of the mediums flowing therepast. Thus, even where there is poor distribution in the manifolds of the exchanger, the exchanger of this invention will not be harmfully affected by the temperature differences in any one medium. Also, even where, for instance, one medium uniformly enters the exchanger at one temperature and uniformly leaves the exchanger at a different temperature, the exchanger of this invention will handle the medium without incurring any harmful thermal stresses in the process.

Still another broad object of this invention is to provide a heat exchanger and a method of making same, wherein the exchanger parts are relieved of all strain, which is created by temperature differences within the exchanger, and which sets up thermal stresses leading to failure of the exchanger.

Other objects and advantages will become apparent upon reading the following description in light of the accompanying drawings wherein:

FIG. 1 is a front elevational view of a heat exchanger with a part thereof only fragmentarily shown.

FIG. 2 is a side elevational view of the exchanger shown in FIG. 1.

FIG. 3 is a top plan view of parts of the exchanger shown in FIG. 1, and with the dotted lines thereof indicating thermal expansion.

FIG. 4 is a view of a fragment of the parts of the exchanger shown in FIG. 1, and with the dotted lines thereof showing the parts in thermal expansion.

This invention is shown by the embodiment of a heat exchanger having an upper header 10 and a lower header 11, each with their conduits 12 in fluid-flow communication with the header. It will therefore be understood that liquid, for instance, will enter the conduits 12 and flow through the exchanger in one direction, such that, for instance, the liquid may first enter the header 10, and flow down to the header 11. Thus, a plurality of tubes 13 extend between the headers 10 and 11, and are of course in fluid-flow communication therewith for directing the liquid as described.

Header plates 14 and 16 are attached to the headers 10 and 11 respectively, and FIG. 3 shows that the tube ends 17 extend through and beyond the header plates 14 and 16 by extending through openings 18 which have a shape identical to the periphery of the tubes 13, which is of course oval-shaped, as shown. FIG. 2 also shows the tube ends 17 extending beyond the respective plates 14 and 16. Also, two rows of tubes 13 are shown in FIGS. 2 and 3.

Serpentine-shaped fins 19 are disposed intermediate the tubes 13, and extend between the plates 14 and 16, though of course they are, for convenience of showing and display, only fragmentarily shown in FIG. 1. FIG. 2 shows that the fins 19 extend through substantially the depth of the tubes 13, so that they extend at least through the flat-sided portions of the tubes 13. Also, a sheet 21 is shown in contact with fin crests 22, and FIG. 1 shows the two sheets 21 to be spaced apart to present a space indicated 23 between the two sheets for an important purpose hereinafter mentioned. Also, a side sheet 24 is shown in contact with the fins 19 extending on the sides of the exchanger. A similar planular sheet 26 exits along the opposite side of the exchanger, and is also in contact with the fins on that side.

It will therefore be understood that a plurality of units are provided in the exchanger, and the units consist of the tube 13 and the fin 19 and the planular sheet 21. These units are of course arranged in parallel and spaced-apart relation to have the space 23 extending therebetween. At this time it will also be now noted and mentioned that the side sheets 24 and 26 are spaced from

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the header and header plates 14 and 16 by the spaces indicated 27 and 28. Therefore, there is no direct or indirect contact from the side sheets to the header plates, and thus any tendency for, for instance, the side sheets to contract when subjected to a low temperature, and the header plates 14 and 16 to expand when subjected to a high temperature will not induce any thermal stresses between the two elements, since they are not in contact, nor connected together. Likewise, the planular or fin sheets 21 are not connected together, and are spaced apart, as mentioned and shown, so that the header plates 14 and 16 may expand and contract freely without being restrained by any of the parts within the core of the exchanger, consisting of, of course, the units described. Thus, the sheets 21 can move together and move apart without inducing thermal strain on the exchanger.

FIGS. 3 and 4 show, in dotted lines, the effect of different temperatures applied to the exchanger. Here, it will be noted in FIG. 3, for instance, that when air is flowing into the exchanger, in the direction of the arrow indicated "A," and of course it being assumed that this is cool air, the edge 31 of the header plate 14 will be cooler than the edge 32 of the header plate 14. This will of course cause the header plate 14 to tend to assume the position shown in the dotted line 33, and thus the edge 32 is expanded or extended, and this of course causes the tubes 13 in the core to likewise be displaced. Of course if these tubes 13 were restrained through direct contact with adjacent tubes or fins along the lengths of the tubes, then thermal strains would be induced in the exchanger core. However, as previously mentioned, the tubes 13 are not physically connected along their lengths with the adjacent tubes or other intervening members connecting the tubes, and therefore the tubes 13 are free to be displaced along with the thermal expansion of the plate 14, and thus there is no thermal strain or stress induced on the exchanger. FIG. 4 also shows in dotted lines the manner in which the tubes 13 can assume new positions under the expansion of the header plate 14, and here again, the exchanger will not be subjected to thermal stress since the tubes 13 are free to expand along with the header plate 14.

Of course in the exchanger, the several parts of the exchanger units defined are normally bonded together. Thus, it is of course common to have fins 19 provided with a metallurgical bonding coating on both sides of the fins so that, for instance, the fin crests 22, in contact with the sheets 21, will become bonded when subjected to a bonding bath or temperature. Likewise, the fins 19 will become bonded to the tubes 13 when properly treated, as mentioned. Also, of course, the side sheets 24 and 26 will become bonded to the fins 19. Thus, the units consisting of the tube 13 and fins 19 on both sides of a central tube, for instance, and also the sheets 21 on both sides of one tube 13 will be bonded together as one unit.

With respect to the method of making the exchanger, it will of course be understood that the exchanger consisting of the units of the tubes 13, and the fins 19, and the sheets 21, will be placed in stack relation as shown in FIG. 1. The sheets 21 have a spacer sheet 34 disposed therebetween. It will of course be understood that while FIG. 1 shows only one spacer sheet 34, every two planular sheets 21 have a spacer sheet 34 disposed therebetween in the initial assembly of the core. The core is then of course fixtured to be compressed together by placing inward pressure on the side sheets 26, and the header plates 14 and 16 are provided with their openings 18 and are assembled with the extending tube ends either before or after fixturing, and of course the core is then placed in the bonding bath so that all of the points of contact of the fins 19 with the tube 13 and the sheets 21 become bonded in the bath. The spacer sheet 34 is of a steel material while the remainder of the exchanger may be of an aluminum base material, and after the bonding, the spacer sheet 34 may be removed from between the sheets

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21 to leave the spaces 23 between every two sheets 21, as shown. Thus, it will be understood that the sheets 21 and 34 are not bonded together in the process as the sheets 21 either may not have coating material thereon, or the coating material may not be effective in adhering to the spacer sheet 34 because of the nature of the sheet 34, such as the steel material mentioned, or the sheet 34 may be coated to resist the adhesion of the bonding material, if there be any on the sheets 21.

Likewise, the exchanger could of course be arranged without sheets 21, and with only the spacer sheet 34 disposed between the fins 19. Then, upon, and subsequent to bonding, the sheet 34 could again be removed to leave a space, such as the space 23 between the crests 22 of the fins 19. Still further, the exchanger could obviously be arranged by having only one sheet 21 between every two fins 19, and the one side of the sheet 21 could resist bonding to the fins 19 adjacent to that side, while the opposite side of the sheet 21 would bond to the fins 19 adjacent to the opposite side. Thus, the sheet 21 could have a bonding-resistant material along the first side mentioned, so that upon bonding of the core, the one side of the sheet 21 and the adjacent fin 19 would not be bonded together and thus the header plates 14 and 16 could expand without being restrained by the fins and sheets, since they are not continuously bonded together to the core, but instead are perhaps only in initial contact, but allow for expansion because they are not bonded as mentioned. Normally, of course the tubes 13 are not of a coated material for bonding, and thus the fins 19 are coated for bonding and will bond and adhere to the surfaces in contact therewith, except where a bonding-resistant material may be applied to, for instance, the sheet 21 as mentioned.

FIG. 2 shows that the side sheets are preferably in two sections, such as the two sheets 26 so that here again, the headers 14 and 16 are allowed to expand without being restrained by the side sheets 26 acting through the fins and tubes adjacent thereto. The side sheets 26 of course physically protect the sides of the exchanger from damage, and they also assist in directing the air through the exchanger, and resist air flowing away from the exchanger as it increases in temperature during the course of flowing through the exchanger.

While a specific embodiment of this invention is shown and a specific method of making same is described, it will of course be understood that certain changes could be made in both the embodiment and the method, and the invention therefore should be limited only by the scope of the appended claims.

What is claimed is:

1. A method of making a heat exchanger adapted to withstand thermal stresses, comprising the steps of assembling a plurality of tubes with a header plate to have the ends of said tubes be in contact with and project through said header plate, assembling a plurality serpentine-shaped fins between said tubes and in contact therewith and present a continuous space between the entire extent of adjacent ones of said fins, disposing a flat sheet in said continuous space and having a metallurgical bonding-resistant material on one side of said sheet and being in contact with said fins on the other side of said sheet, said fins being selected from material having a metallurgical bonding coating thereon, fixturing said tubes and said fins and said sheets inwardly toward each other and fusing all the aforementioned elements together at their points of contact which have said bonding coating.

2. In a heat exchanger core of the fin-and-tube type adapted to withstand thermal stresses, the combination comprising a plurality of flat-sided tubes disposed in axially parallel and spaced-apart relation, a serpentine-shaped fin bonded to each opposite flat side of each of said tubes and including crests extending therefrom and disposed along a plane offset from and parallel to the axis

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of each of said tubes, and with said planes being spaced apart to present a continuous space between said crests throughout the entire area of said planes, flat sheets bonded to said crests along each of said planes on each side of each of said tubes and also being spaced apart to present a continuous space between said sheets, and a header plate bonded to each of the opposite ends of said tubes for directing the flow of fluid with respect to said tubes and governing the spacing between said tubes.

3. A method of making a heat exchanger adapted to withstand thermal stresses, comprising the steps of assembling a plurality of units comprising the elements of a tube and a fin and a flat fin sheet in a stacked relation with a spacer sheet disposed between each two successive ones of said units and adjacent said flat fin sheets, arranging to have the opposite ends of said tubes extend beyond the remainder of said units and project through header plates and assembling the latter on each end of said tubes, said fins and said flat fin sheets being selected from material having a metallurgical bonding coating thereon and said spacer sheet being selected from steel material having no metallurgical bonding coating thereon, fixturing said units and said spacer sheet inwardly

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toward each other, fusing said elements of said units and said header plates together through melting said bonding coating, and removing said spacer sheet and leaving a space between said units.

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