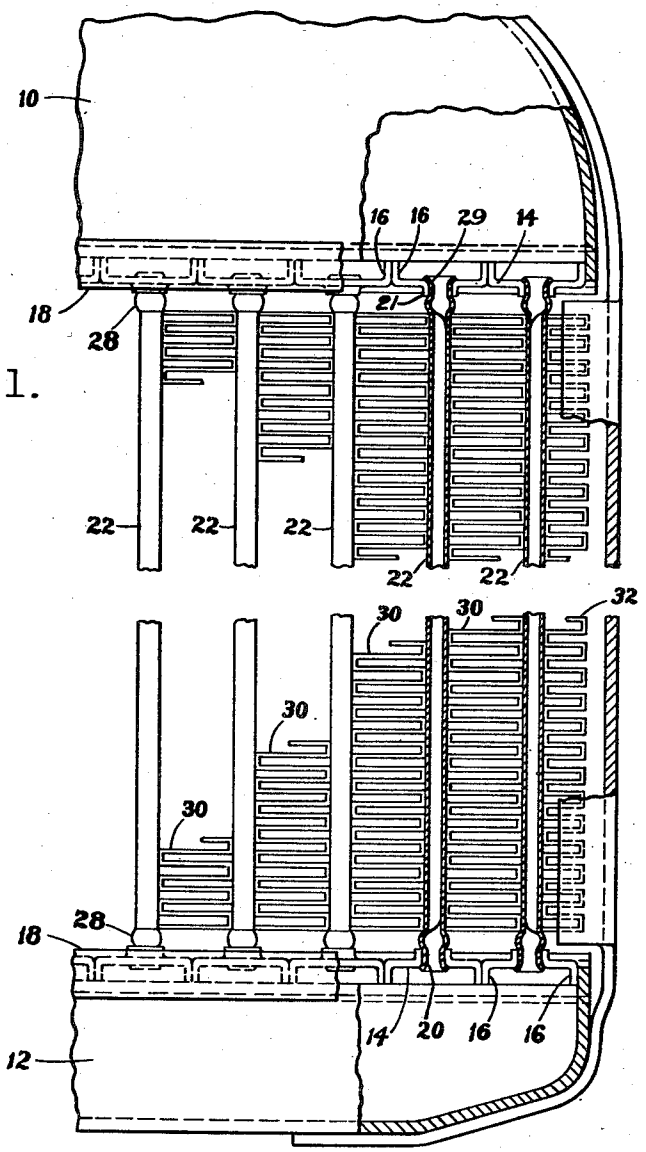
Oct. 30, 1951 A. O. TADEWALD 2,573,161

HEAT EXCHANGER

Filed Dec. 12, 1947 3 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

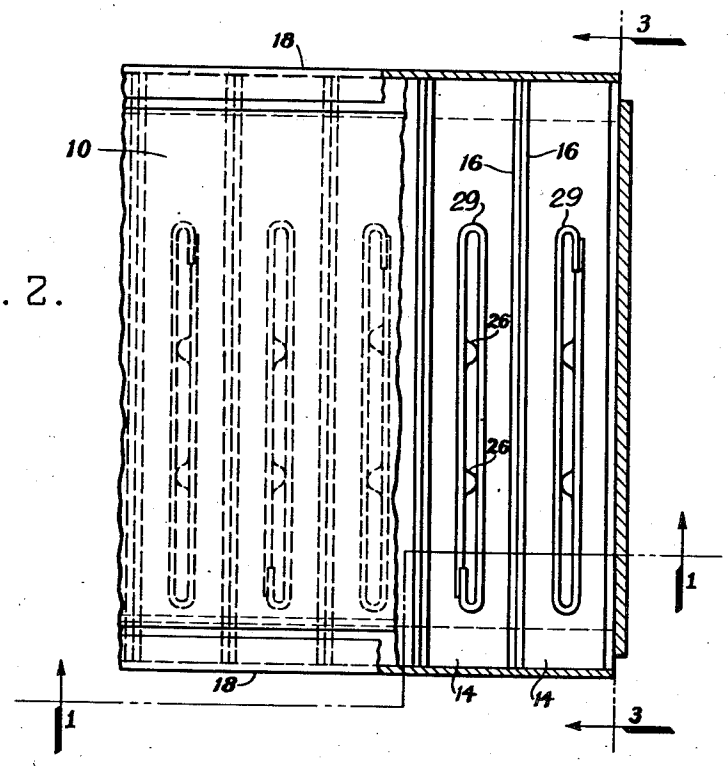
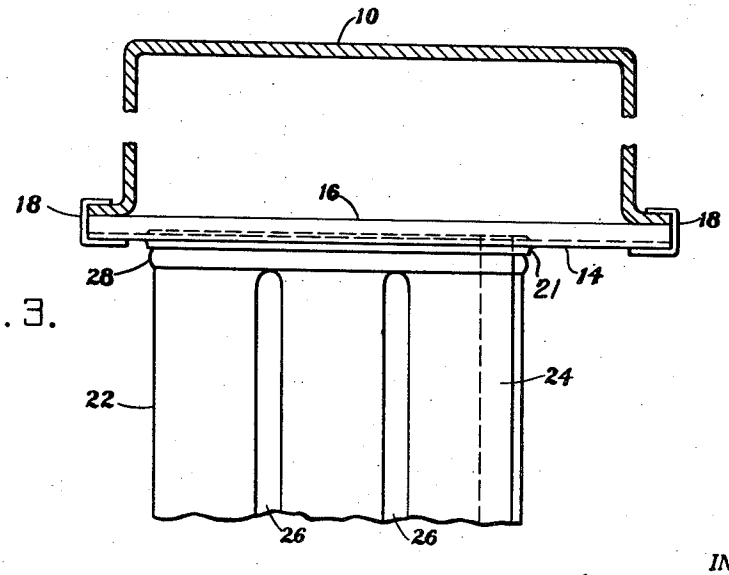


Fig. 3.



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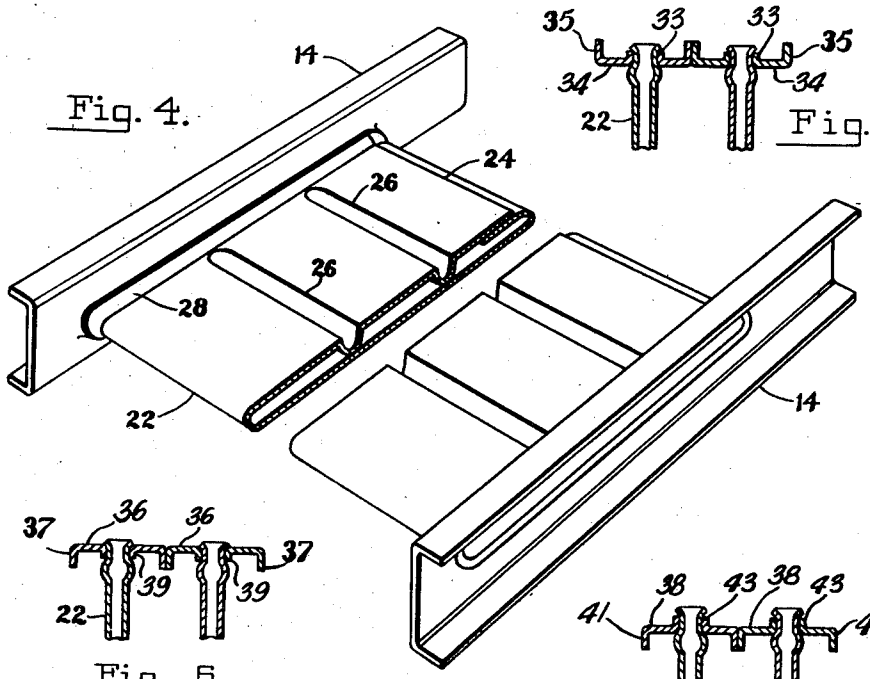


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

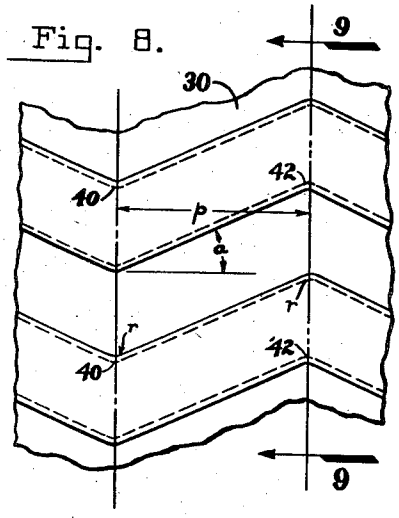


Fig. 8.

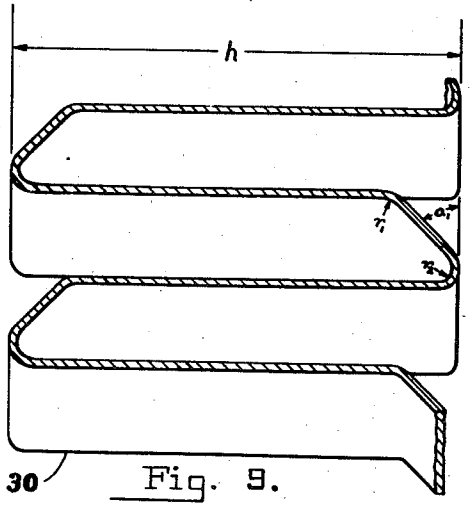


Fig. 9.

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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

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Application December 12, 1947, Serial No. 791,408

6 Claims. (Cl. 257—130)

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This invention relates to heat exchangers and more particularly to heat exchangers which are suitable for use as radiators for internal combustion engines.

One object of the invention is to provide a heat exchanger which is simple and inexpensive to manufacture and assemble and which has a high heat transfer capacity.

Another object of the invention is to provide a sectional header construction which gives increased strength and which allows the tubes, fins, and headers to be readily assembled and held in place for the welding operation.

Another object of the invention is to provide a fin construction which gives increased strength to the unit and also a higher rate of heat transfer.

Further objects of the invention will become apparent from the following detailed description taken in connection with the drawings which form a part of this application, and in which

Fig. 1 is a front elevation of my improved radiator partly in section taken on lines 1—1 of Fig. 2.

Fig. 2 is a top plan view partly in section.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2 with the fin sheet removed.

Fig. 4 is a perspective view of a tube and its header channels showing one step in the assembly of the radiator.

Fig. 5 is a sectional view showing a modification of my invention.

Fig. 6 is a sectional view showing another modification of my invention.

Fig. 7 is a sectional view showing still another modification of my invention.

Fig. 8 is a view looking at the side of the fin sheet.

Fig. 9 is a sectional view of the fin sheet taken on the line 9—9 of Fig. 8.

Referring to the drawings, the radiator of my invention has an upper tank 10 and a lower tank 12. Each tank has a header which consists of a plurality of channels 14 which in the finished radiator are welded or brazed together along the outside surfaces of their flanges 16. The tanks are welded to the ends of the headers by having the ends of the tanks overlap the outside flange of the end channels. The sides of the tanks are fastened to the headers by means of channels 18. Each of the channels 14 has a flanged, round ended slot 20 struck from the web. In the preferred embodiment shown in Figs. 1–3 the flanges 21 of the slot 20 extend in the opposite direction from the flanges 16 of the channel. Heat exchange medium flows from tank 10 to tank 12

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through tubes 2. The tubes are formed of sheet material with an overlapping seam 24. The tubes 22 have two longitudinal corrugations 26 which are deep enough so that the material of the two sides may be in contact for welding along the corrugation. It should be understood that one corrugation or a number exceeding two could be used if desired. The tubes each have transverse outwardly extending beads 28 a short distance from each of their ends, and they have outwardly flared ends 29.

Figs. 5, 6, and 7 show three modifications of the preferred embodiment of my invention which is shown in Figs. 1–4. In the form of Fig. 5 the channels 34 correspond to the channels 14 of Figs. 1–4, but in this form the flanges 33 of the tube receiving hole extend in the same direction as the flanges 35 of the channel. Fig. 6 shows the channels 36 of the header with the flanges 37 of the channel and the flange 39 of the hole extending in the same direction and away from the header.

Fig. 7 shows the channels 38 of the header with the flanges 41 of the channels extending away from the header and the flange of the holes 43 extending the opposite direction.

Fin sheets 30 extend between the tubes and they are preferably welded or brazed to the tubes. Fin sheets 32 are welded to the outside surface of the tubes at each end of the radiator.

The thickness of the material of the fin sheets has been exaggerated in Fig. 1 for purpose of illustration, but in actual practice the thickness would be approximately between four and thirty thousandths of an inch, but preferably about six thousandths of an inch. The fins may be straight in the direction of air flow, however I prefer to use a fin which is corrugated in the direction of air flow as is shown in Figs. 8 and 9. The actual dimensions for the fin sheet will be given in order to show the relative size and shape of the fin, but it should be understood that these dimensions can be varied considerably without departing from the spirit and scope of my invention. The height "h" of the corrugations which extend generally in the direction of air flow is approximately .421 inch, but this dimension can be varied considerably according to the particular application. My preferred spacing of the fins is such that there are approximately twelve fins to the inch, but as few as six per inch or as many as 14 per inch would be practical for some applications. The shape of the peaks of these corrugations is such that r_1 is about .040 inch and r_2 is .017 inch. The fin has a flat por-

tion making an angle a_1, of 45°, because if this were not done the material would have a tendency to tear at this point because it would have a sharp convex curvature in two planes at right angles to each other. The corrugations which extend transversely to the direction of air flow have a shape such that the distance p between the troughs and the peaks is .1875 inch. The angle a is then made 24°—21'—26.2'' in order that the points 40 may be opposite the points 42.

The radius r should be small in order to create turbulence in the air to increase the rate of heat transfer. I prefer that the radius r should be about .020 inch. It should be understood that the radius r could be increased slightly without seriously reducing the heat transfer capacity. The dimension p and the angle a could also be varied, but I prefer that they should be such that the points 40 are opposite the points 42. The portions of the fins between the troughs and peaks are substantially straight as shown except where they are joined on radius r. It should be understood that clearance between the dies is necessary and that the dimensions of the finished fin sheet may vary slightly from those specified above.

In assembly of the heat exchanger, a channel 14 is slipped on each end of a tube 22 with the end of the tube extending through the slot 20 in the channel and with the edge of the flange of the slot 20 resting against the bead 28 on the tube. The ends of the tubes are then flanged outwardly to lock the channels on the tube. In this way the beads 28 accurately determine the spacing of the channels 14 of the headers. The fin sheet 30 may then be placed on the tube between the channels 14, and another tube and channel assembly added. Fin sheets and tube and channels assemblies are then added to the stack in the above described manner until the desired size of heat exchanger has been assembled.

Pressure is then applied to the top and bottom of the stack so that the peaks of the longitudinal corrugations of the fins are deformed slightly into good contact with the tubes, and the flanges of the channels are pressed against each other for welding.

My preferred method of welding the parts into an integral whole is to use, for the parts, material which has a thin coating of lower melting material on its surface so that when the assembly is heated to the melting point of the surface material, the parts are welded together without melting the base material of the parts. The welding coating may be on only one surface of the two surfaces which are to be welded.

While I have described the foregoing preferred embodiments of my invention, I contemplate that many changes may be made without departing from the scope or spirit of my invention, and I desire to be limited only by the claims.

I claim:

1. A heat exchanger comprising a supply header and a return header, one side of each header comprising a plurality of channels, the flanges of said channels extending away from the interior of the header, each of said channels having a hole in its web, tubes extending between the channels of said supply header and the channels of said return header and having their ends extending into the holes in said channels, and the ends of the tubes being flared outwardly to prevent disengagement of the channels from the tubes.

2. A method of making a heat exchanger comprising forming a flat tube with longitudinal partitions by forming one or more indentations lengthwise of a sheet and of sufficient depth to contact the other side of the finished tube, forming outwardly extending beads near each end of the sheet, forming the sheet into a flat tube with the longitudinal edges overlapping, inserting each end of the tube into an elongated hole in a channel member until the channel members contact the bead on the tube, deforming the ends of the tube outwardly against the channel members to form a first tube and channel assembly, placing a fin sheet on said first tube and channel assembly with the fin sheet extending between the channels, adding a second tube and channel assembly with the tube of said second mentioned tube and channel assembly resting on the fin sheet, and with the channels of said second assembly aligned with the channels of said first assembly, adding fin sheets, and tube and channel assemblies in the above recited manner until the desired size of heat exchanger has been obtained, applying pressure to the top and bottom of the stack to compress the fin sheets against the tubes and the channels against each other, and heating the entire structure to weld the parts into an integral piece.

3. A heat exchanger comprising a supply header and a return header, each header having a tube sheet, each of said tube sheets comprising a plurality of channels, each of said channels having a web and substantially flat flanges extending substantially normal to said web, the outside surfaces of said flanges being welded to the outside surfaces of the flanges of the next adjacent channels, each of said channels having a hole in its web, tubes extending between the channels of said supply header and the channels of said return header and having their ends extending into the holes in said channels, and the ends of the tubes being flared outwardly to prevent disengagement of the tubes from the channels.

4. A heat exchanger comprising a supply header and a return header, each header having a tube sheet comprising a plurality of channels, each of said channels having a web and substantially flat flanges extending substantially normal to said web, the outside surfaces of said flanges being welded to the outside surfaces of the flanges of the next adjacent channels, each of said channels having a flanged hole in its web, tubes extending between opposite channels of the respective headers and having their ends extending into said flanged holes and the ends of said tubes being flared outwardly to prevent disengagement of the tubes from the channels.

5. A heat exchanger comprising a supply header and a return header, each header having a tube sheet comprising a series of channels welded together at the outside surfaces of their flanges, each of said channels having a flanged hole in its web, tubes extending between opposite channels of the respective tube sheets and having their ends extending into the flanged holes, said tubes having near each end an outwardly formed bead engaging one end of the flange of one of said openings, each end of each of said tubes being flared outwardly to engage the other end of the flange of said opening, and metal sheets having a plurality of corrugations, the peaks of said corrugations being welded to the outside surfaces of said tubes.

6. A heat exchanger comprising a supply header and a return header, one side of each header

comprising a plurality of channels, the flanges of said channels extending toward the interior of the headers, the outside surfaces of the flanges being welded to the outside surfaces of the flanges of the next adjacent channels, each of said channels having a hole in its web, tubes extending between the channels of said supply header and the channels of said return header and having their ends extending into the holes in said channels, and the ends of the tubes being flared outwardly to prevent disengagement of the channels from the tubes.

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