

Aug. 4, 1953

E. LUDLOW

2,647,731

RADIATOR CORE CONSTRUCTION

Filed Aug. 17, 1951

2 Sheets-Sheet 1

Fig. 1.

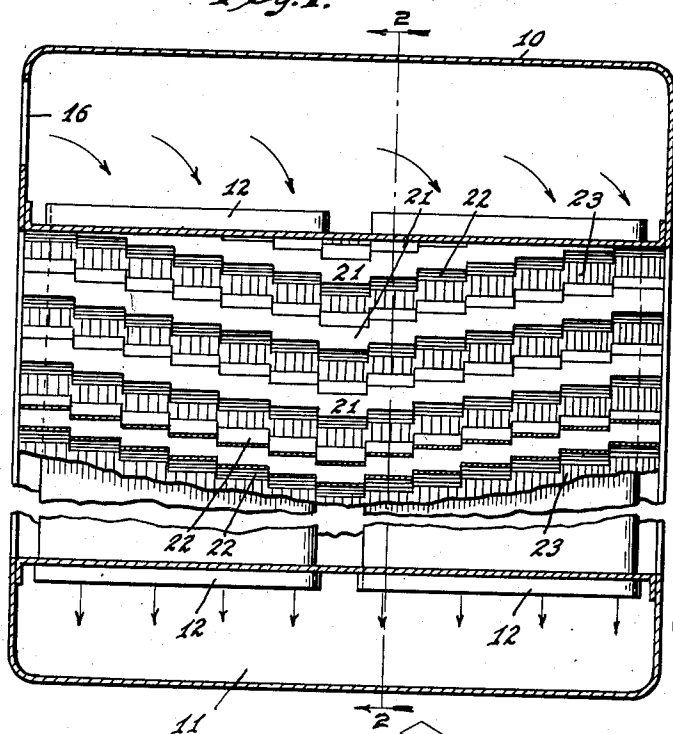


Fig. 2.

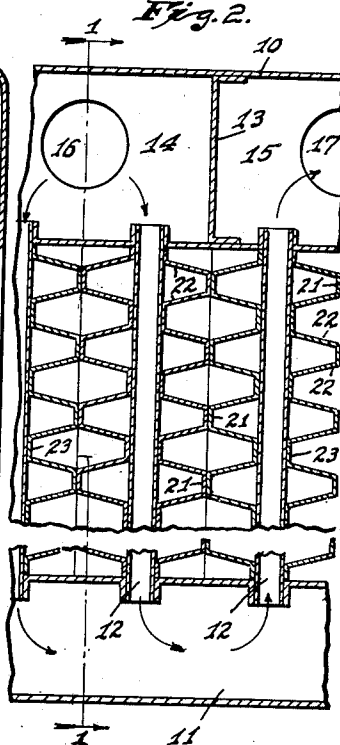


Fig. 3.

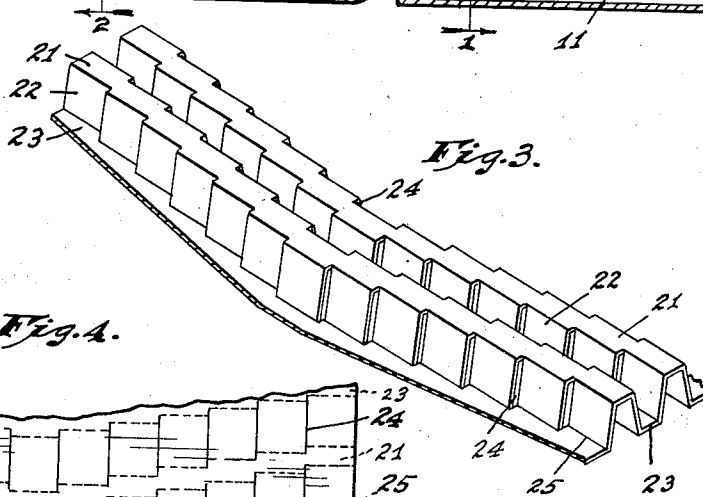
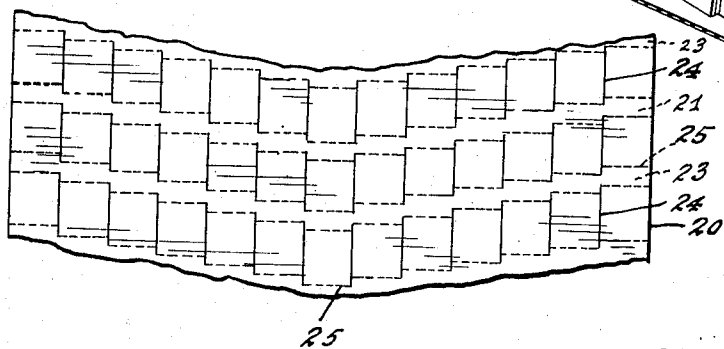


Fig. 4.



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Fig. 5.

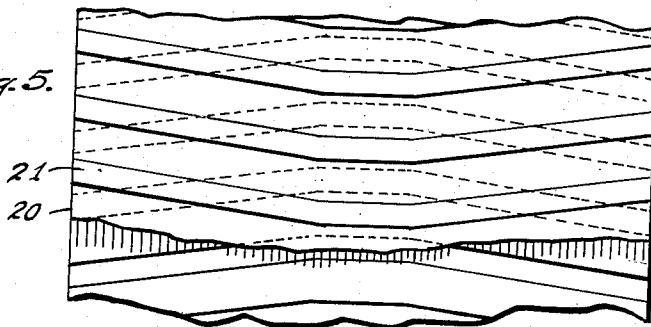


Fig. 6.

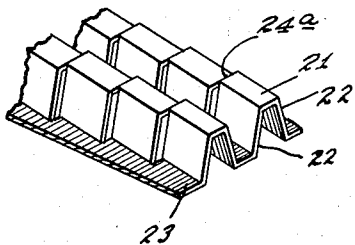


Fig. 8.

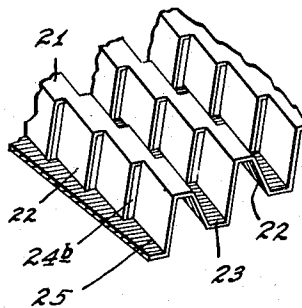


Fig. 7.

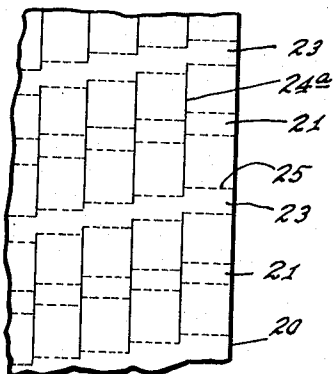
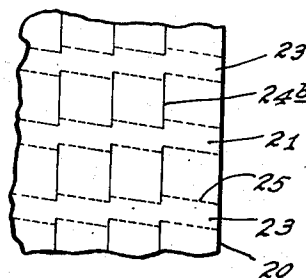


Fig. 9.



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RADIATOR CORE CONSTRUCTION

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3 Claims. (Cl. 257—130)

1 This invention relates to heat exchangers of the general type exemplified by automobile radiators and the cores of hot-water heaters for use in automobiles. Such heat exchangers commonly employ a pair of spaced headers interconnected by a plurality of thin-walled, spaced tubes. Liquid flows through the tubes and air through the spaces between the tubes. To improve the rate of heat exchange between the liquid and the air, it is common to dispose in the spaces between the tubes metal heat-transfer elements which are in intimate heat-transferring relationship with the tubes and which present large areas for contact with the air flowing through the spaces between the tubes.

It is an object of this invention to improve the construction of the heat-transfer elements above referred to. A further object of the invention is to produce a heat-transfer element which will possess improved effectiveness in transferring heat to the air flowing over it and which will not oppose undue resistance to the flow of such air. A further object of the invention is to provide a heat-transfer element which can be simply and economically constructed and readily assembled with the other elements of the heat-exchanger.

A heat-transfer element embodying my invention is perhaps most conveniently described as comprising an elongated strip of thin metal of relatively high heat-conductivity bent repeatedly and reversely along transverse lines to define transversely extending, spaced ribs. The side walls of such ribs are provided with parallel slits located in planes generally perpendicular to the ribs and dividing each rib into a plurality of rib-
25 portions. Adjacent rib-portions are offset from each other transversely of the rib, each slit thereby forming an opening which is presented longitudinally of the rib and which provides communication between the interior of the rib and the space between such rib and an adjacent rib. Preferably, the side walls of the individual rib-
30 portions are parallel to the direction of air flow through the core so that such side walls themselves do not tend to deflect the air laterally with respect to its general direction of flow. At each slit-formed opening, however, every air stream passing through a rib or through the space between ribs is divided; and as there are a mul-
35 tiplicity of slits in each rib, the division of each air stream is repeated many times as the air flows through the core.

The accompanying drawing illustrates the invention: Fig. 1 is a section through a heat-exchanger core on the line 1—1 of Fig. 2; Fig. 2

2 is a fragmental section on the line 2—2 of Fig. 1; Fig. 3 is a fragmental isometric view illustrating one of the heat-transfer elements; Fig. 4 illustrates a development into a plane of the heat-transfer element shown in Fig. 3; Fig. 5 is a diagrammatic view illustrating the preferred arrangement of heat-exchanging elements in a core; Figs. 6 and 7 are fragmental views similar respectively to Figs. 3 and 4 but illustrating a modified construction; and Figs. 8 and 9 are also views respectively similar to Figs. 3 and 4 illustrating a further modification.

The heat-exchanger illustrated in Figs. 1 to 4 comprises an upper header 10, a lower header 11, and a plurality of wide, thin, flat-walled tubes 12 interconnecting such headers. In the particular arrangement illustrated, the upper header 10 is divided by a transverse partition 13 into two chambers 14 and 15 provided respectively with inlet and outlet openings 16 and 17. Liquid enters the opening 16 into the chamber 14, flows downwardly through the tubes 12 communicating with that chamber, transversely through the lower header 11 and upwardly through the remain-
25 ing tubes into the outlet chamber 15. The tubes 12 are shown as arranged in pairs, the two tubes of each pair being coplanar and spaced from the tubes of other pairs. In use, liquid circulates through the tubes 12 as previously described, air flows through the spaces between adjacent pairs
30 of tubes, and an exchange of heat takes place between the air and the liquid.

My invention relates to heat-transfer elements which are disposed in the spaces between adjacent pairs of tubes 12 in intimate heat-receiving relationship with the walls of the tubes and which project outwardly from the tubes to present large surface areas for contact with air flowing through the core. A preferred form of heat-transfer element is illustrated in Figs. 1 to 4. Such heat-transfer element is formed of an elongated strip 20 of metal, such as copper, possessing high heat-conductivity. As will be clear from Figs. 2 and 3, the strip 20 is repeatedly and reversely bent to provide ribs extending transversely of the strip. Each such rib possesses an outer wall 21 and side walls 22, and adjacent ribs are interconnected by inner walls 23. The side walls of each rib are provided with slits 24 which, in effect, divide each rib into a mul-
45 tiplicity of rib-portions, and adjacent ones of those rib-portions are offset from each other transversely of the rib so that the slits 24 form openings presented longitudinally of the rib and providing communication between the interior of

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the rib and the space between it and the adjacent rib.

It will be apparent that air entering the core in a direction normal to the face thereof and parallel to the general direction in which the ribs extend will be divided into independent streams, some of which enter the several ribs and others of which enter the spaces between the ribs. As the air proceeds through the core, each individual stream is in turn subdivided repeatedly at the openings provided by the slits 24. I have found the division and repeated subdivision of the air stream to be very effective in improving heat-transference.

In the preferred form of core, the offsetting between adjacent rib-portions is progressively in one direction from one edge of the strip 20 to the center thereof and is then progressively in the opposite direction from the center to the opposite edge of the strip. The aggregate amount of offsetting between each edge of the strip and the center thereof desirably exceeds the width of the rib, so that it will be impossible for air to pass in a straight line through the core without encountering one of the slit-formed openings 24.

In the developed view constituting Fig. 4, it will be obvious that the slits 24 are arranged in transverse rows which generally accord with the shape of the ribs in the finished heat-transfer element. That is, the slits 24 are arranged in transverse rows, the slits in each row being offset from each other progressively in one direction from one edge of the strip to the center thereof, and then in the other direction from the center to the opposite edge of the strip. The slits are likewise arranged in longitudinal rows, the slits in each longitudinal row being in alignment with each other. In Fig. 4, the dotted lines 25 represent the lines at which folds exist in the finished heat-transfer element.

The heat-transfer element described lends itself to manufacture by inexpensive and simple equipment, as each element may be formed in a single rolling operation which simultaneously bends the metal and cuts the slits 24. Since the offsetting in each rib is in opposite directions from the center of the strip 20 toward the edges thereof, any lateral forces exerted on the strip during the forming operation are balanced, and there is no tendency of the strip to move laterally of itself in the rollers which form it.

Conveniently, two of the heat-transfer elements are disposed between adjacent pairs of tubes 12, the heat-transfer elements extending for the full thickness of the core, and each element having its inner walls 23 in contact with the side walls of a pair of tubes 12 and its outer walls 21 in contact with the outer walls of the associated heat-transfer element. It will be obvious that any heat-transfer element can be positioned in the core with the offsetting in each rib progressing either downwardly or upwardly from the center of the element toward the outer edges thereof. For convenience, I prefer that the two heat-transfer elements located between adjacent pairs of tubes 12 be disposed oppositely, as indicated in Fig. 5, so that the ribs of one of such elements cross the ribs of the other.

Heat-transfer elements constructed in accordance with my invention possess several advantages in addition to their effectiveness in dividing and subdividing the air which flows through the core. It will be noted, for example, that the inner, tube-engaging walls 23 of each element are

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plane and uninterrupted. As a result, when, as a final step in core-assembly, the face of the core is immersed in molten solder, the solder will be drawn by capillary attraction between the tube-walls and the inner element-walls 23 to provide an effective heat-transfer joint. It will also be noted that the slits 24 lie in planes normal to the side-walls of the tubes 12 and hence do not cut across and interrupt the lines of heat flow in the heat-transfer element.

The modification illustrated in Figs. 6 and 7 is essentially the same as that shown in Figs. 1 to 4 except for the fact that the slits 24a are longer than the slits 24 and extend across the outer rib wall 21 as well as across the side walls.

The modification illustrated in Figs. 8 and 9 differs from that of Figs. 3 and 4 in that the slits 24b in any one transverse row are not offset from each other longitudinally of the strip. The fold lines 25 in the modification of Figs. 8 and 9 do not extend perpendicularly of the slits, but instead depart from perpendicularity by a slight amount, as indicated, to provide the desired offsetting of the rib-sections.

All modifications shown have in common the fact that the slits are arranged in longitudinal and transverse rows and that each fold line 25 marking the junction of a side wall 22 and the contiguous inner wall 23 extends from one end of a slit in one longitudinal row to a point intermediate the ends of the corresponding slit in the next longitudinal row.

I claim as my invention:

1. A heat-transfer element for use in a heat-exchanger, comprising an elongated metal strip provided with transversely extending rows of parallel, longitudinally extending slits of substantially equal length, adjacent slits of each row being offset from each other longitudinally of the strip for a distance equal to a small fraction of the slit-length, the metal between adjacent slits and between the end slit of each row and the adjacent strip-edge being offset from the plane of the strip to form similar channel-like rib positions, adjacent rib-portions being offset from each other by a distance substantially equal to the offsetting of adjacent slits, the offsetting of the slits and ribs continuing in one direction until at the center of the strip the aggregate amount of offsetting is at least equal to the width of the rib-portions, the offsetting then proceeding similarly but in the opposite direction for the balance of the strip-width.

2. A heat-transfer element for use in a heat-exchanger, comprising an elongated metal strip provided with transversely extending rows of parallel, longitudinally extending slits of substantially equal length, adjacent slits of each row being offset from each other longitudinally of the strip for a distance equal to a small fraction of the slit-length, the metal between adjacent slits and between the end slit of each row and the adjacent strip-edge being offset from the plane of the strip to form similar channel-like rib portions, adjacent rib-portions being offset from each other by a distance substantially equal to the offsetting of adjacent slits, the offsetting of the slits and ribs continuing in one direction until the aggregate amount of offsetting is at least equal to the width of the rib-portions.

3. A heat-transfer element for use in a heat-exchanger, comprising an elongated metal strip provided with transversely extending rows of parallel, longitudinally extending slits of substantially equal length, adjacent slits of each

row being offset from each other longitudinally of the strip for a distance equal to a small fraction of the slit-length, the metal between adjacent slits and between the end slit of each row and the adjacent strip-edge being offset from the plane of the strip to form similar channel-like rib portions, adjacent rib-portions being offset from each other by a distance substantially equal to the offsetting of adjacent slits.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,802,263	Medville	Apr. 21, 1931
1,939,175	Kramer	Dec. 12, 1933
2,133,502	Emmons	Oct. 18, 1938

FOREIGN PATENTS

Number	Country	Date
438,948	France	Jan. 13, 1912