

Sept. 15, 1953

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2,652,233

AUTOMOTIVE TYPE CELLULAR RADIATOR CORE

Filed Jan. 2, 1951

3 Sheets-Sheet 1

FIG. 1.

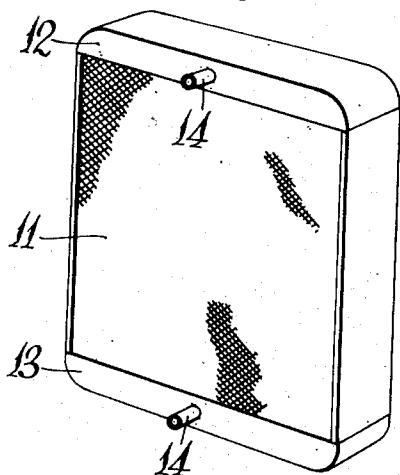


FIG. 7.

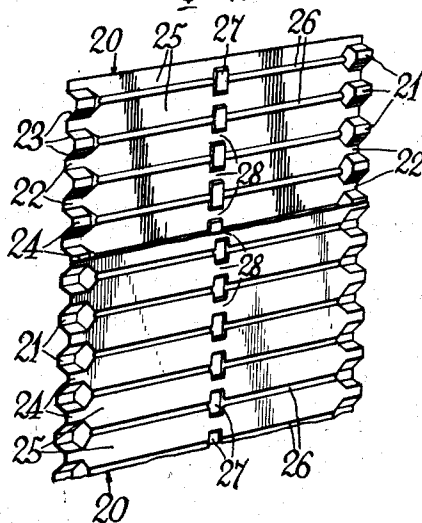


FIG. 4.

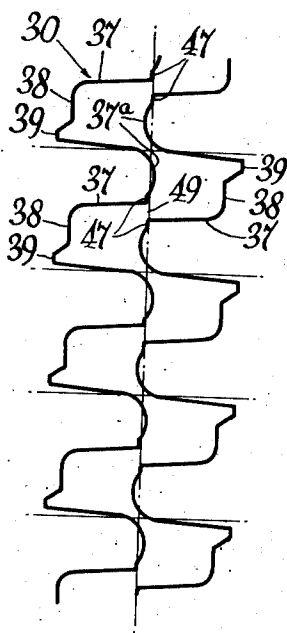


FIG. 5.

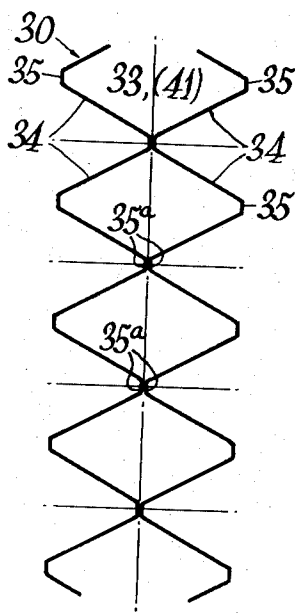
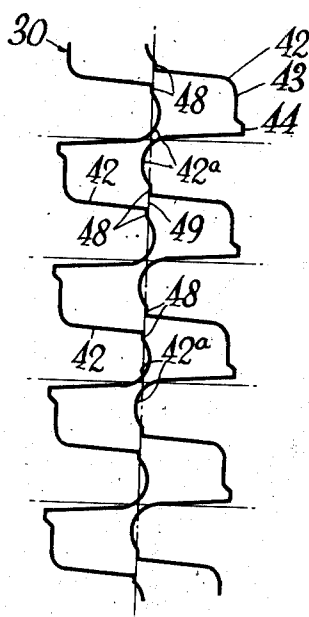


FIG. 6.



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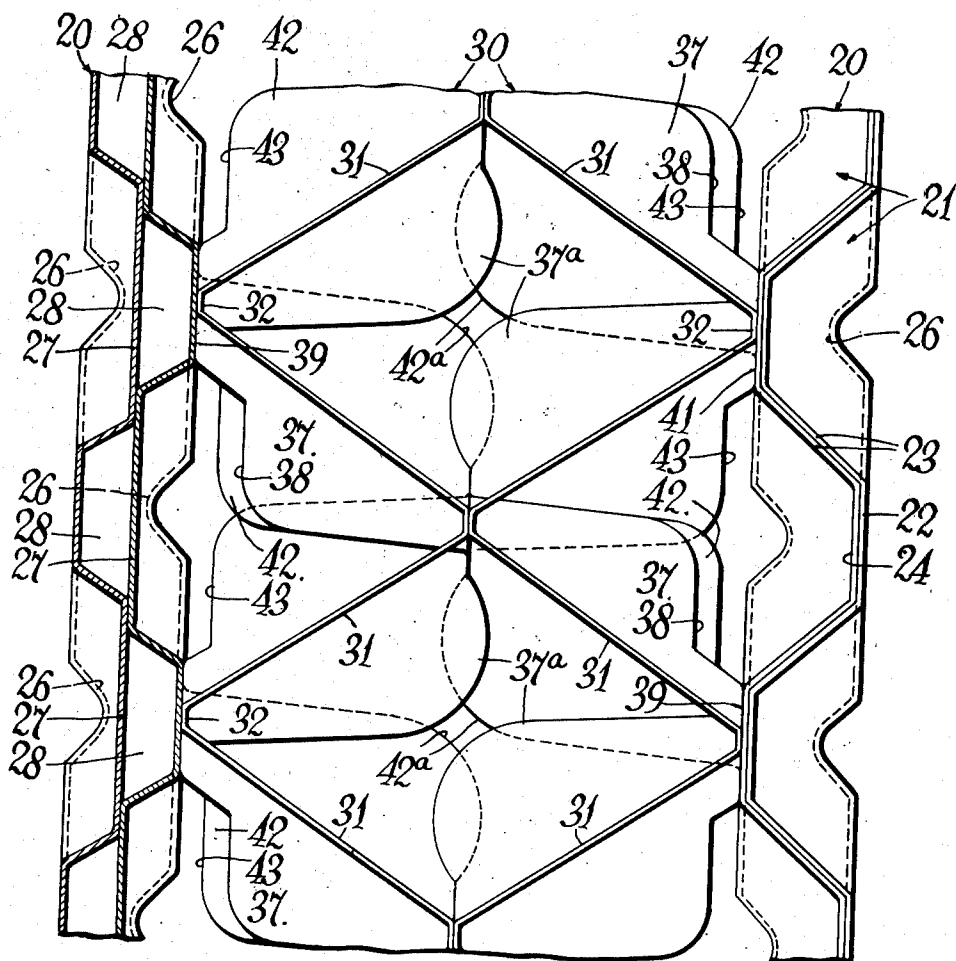


FIG. 2.

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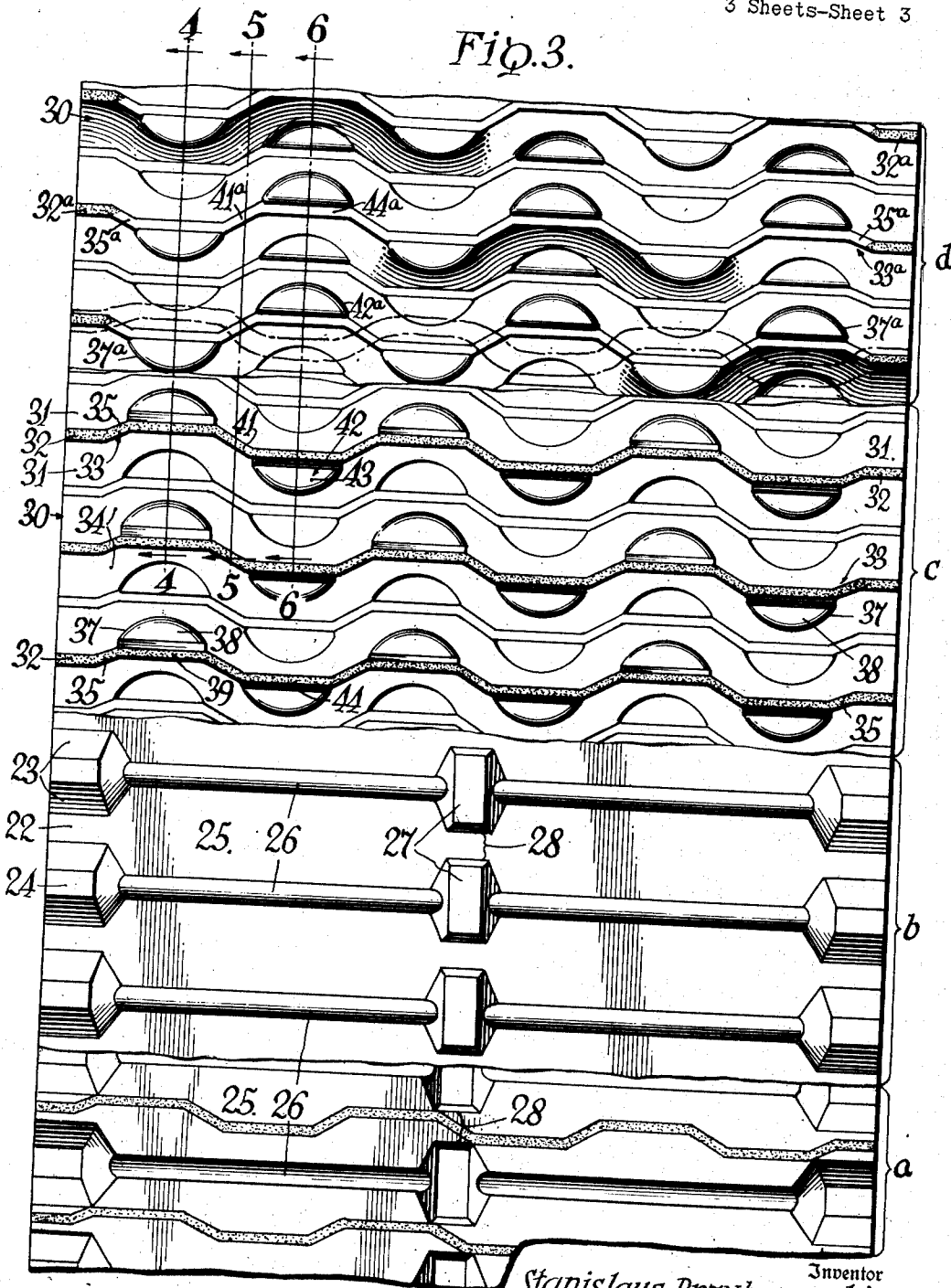
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Fig. 3.



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AUTOMOTIVE TYPE CELLULAR RADIATOR
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Application January 2, 1951, Serial No. 203,842

6 Claims. (Cl. 257-130)

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This invention relates to a radiator of the type utilized in cooling an internal combustion engine, and it has particular reference to the provision of an improved cellular radiator core of relatively low weight and high heat transfer capacity.

One of the basic and well known types of heat exchangers employed for cooling automobile engines, or supplying heat to the interior of the car, and for analogous purposes, is known as a cellular core radiator. In this design, pairs of preformed sheets of brass or copper are superimposed to provide a closed passage through which the water or other coolant may flow, and the water passages are spaced by copper fins so formed as to provide open passages through which air may flow to absorb the heat transferred thereto by the relatively hot engine cooling medium. In actual manufacturing practice, it is expedient to assemble the complete core from subassemblies of the fin stock positioned in jointed lengths of water line stock which envelops the fin on both sides and the ends. The water line stock is therefore commonly referred to as an "outer" ribbon, and the fin material is called an "inner." These subassemblies are then stacked with the "outer" of one contacting the "outer" of the next, to provide a core whose elements may be bonded by solder, and ultimately assembled with end tanks or headers, to provide the complete radiator. The present invention is primarily concerned with a radiator of this type.

Fundamentally, radiator cores are evaluated on the basis of the quantity of heat which the air can extract from the engine coolant, in terms of weight of metal in the core. Many factors enter into this fundamental basis, as the heat transfer capacity varies with the velocity of the coolant through the water passages, the character of its flow, the air speed, and its pressure drop from entering to discharge face of the core, the cooling capacity in terms of unit face area as well as weight, and, of course, the cost of manufacture. An improvement which results in an increase in capacity of a few per cent for the same weight of metal is regarded as of high technical significance. Despite the advances made in recent years in the theory of heat exchange, it is noticeable that they have not contributed in any large measure to the development of improved cellular cores. Those now manufactured in this country in large volume for use in the automotive industry are substantially the same in design as those produced al-

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most a score of years ago—the differences, to the extent that they exist, are largely in variations in proportions of the several elements.

According to the present invention, an improved core of the cellular type is provided, wherein, under equivalent conditions of operation, and compared to a well known current production core, the same amount of cooling may be effected with a saving of as much as twenty-five per cent in the core weight, and wherein, for the same size core, the B. t. u. capacity per unit weight may be more than proportionately increased. A radiator made in accordance with this invention is illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective of a typical heat exchange radiator in which the present improvements may be incorporated;

Fig. 2 is a fragmentary large scale face view of the present core, with a portion of one water line broken away;

Fig. 3 is a fragmentary plan view, on a reduced scale from that of Fig. 2, of the several parts of the core, superimposed on each other, and showing (a) the exterior face of an "outer" ribbon, (b) the interior face thereof, (c) the exterior face of an "inner" ribbon which is in contact with an "outer," and (d) the interior face of an "inner" ribbon which is in contact with a companion "inner" ribbon;

Figs. 4, 5, and 6 are profiles taken on the correspondingly numbered lines on Fig. 3; and

Fig. 7 is a fragmentary perspective, on a smaller scale, of a pair of water line elements.

The typical radiator shown in Fig. 1 comprises a core body 11, composed of the above described subassemblies which have been bonded and integrated by dipping the front and rear faces in a bath of molten solder. In such core, the air flow is through passages from one face of the core to the other, while the water flow is from an upper header or tank 12 to a lower header 13, each of which is provided with a fitting 14 for connection to the engine cooling circuit, as is well understood in the art.

The water line ribbons, pairs of which are superimposed to form the water passages, comprise identical strips 20 of imperforate sheet metal, which are corrugated along their margins to provide semi-hexagonal offsets 21. Each of these includes a base 22, disposed in the initial plane of the ribbon stock, outwardly diverging sides 23, and a plane crest 24 which is parallel to the base 22. The offsets 21 are aligned transversely of the strips 20, and, when a strip is folded

3 on itself, or two individual strips are superimposed, the offsets of one will intermesh with those of the other, to provide a continuous zig-zag edge which can be sealed by solder dipping. The intermediate surfaces 25 of the strips will then be spaced a distance substantially equal to the height of the offsets, to form a water passage.

The surfaces 25 are formed with inwardly extending transverse parallel ridges 26, located midway of the bases 22 and therefore substantially in transverse alignment with the crests 24. These ridges merge at the medial portion of the ribbon 20 into inwardly extending protuberances 27 having generally the form of a truncated four-sided pyramid. They have a height equal to substantially one half the height of the offsets 21, and a top length in excess of the base distance between protuberances. When the ribbons 20 are superimposed, the protuberances 27 therefore abut and overlap the spaces 28 between the protuberances of the companion ribbon, as is best shown in the left hand section of Fig. 2.

It will also be seen from this figure that the water passages are essentially tubular conduits of rectangular configuration, wherein the ridges 26 cause the liquid to change direction toward opposite sides of the passages, and thereby provide a mild, but sufficient, turbulent flow, to prevent stratification of relatively hot liquid through the center portions of the passages. The protuberances 27 support against collapse of the medial portions of the water passages, but do not divide the passages into two hydraulically separated passages, as the spaces 28 are ample to permit transverse flow. It is also to be noted that the plane areas 25 are relatively wide, having a width somewhat greater than the diameter of the hexagonal offsets 21. As will presently appear, these wide areas are utilized in assembling the "inners" with the "outers," without recourse to special forms of locating projections.

The "inner" ribbon or fin, generally designated by the reference numeral 30, is also formed by die stamping or rolling thin sheet metal into such configuration that while opposite surfaces exhibit somewhat different forms, two like surfaces may be intermeshed, while the opposing surfaces may be brought into engagement with the exterior surfaces of the water line ribbons 20. It is therefore contemplated that the core shall be of the "double inner" type, although it may be noted here that the configuration is such that a triple inner construction may be employed, when desired.

The formation of the fin 30 will be described by considering first the exterior face intended to contact a water ribbon 20, and which appears as part (c) of Fig. 3. Referring also initially to the face view of Fig. 2, it will be seen that the margins of the ribbon 30 are deformed into a zig-zag configuration, having sloping sides 31 joined by narrow apices 32. These marginal portions, and their apices, merge into spacer sections 33, which have the same height from the plane of the paper as the apices 32, but which are angularly inclined thereto transversely of the ribbon. A section taken through such a spacer portion will therefore have substantially the same profile as the edge of the ribbon. As will appear from Fig. 5, which is equally applicable to the spacers 33, the spacers have sloping sides 34, and apices 35 of substantially the same narrow width as the apices 32.

The spacer portions 33 in turn merge into longitudinally aligned "outside bumps" 37, this term

being employed to signify that the formations look like, and are known in the art as "bumps," and that these particular bumps are those adjacent the margins of the ribbon. Viewed in plan, each bump 37 appears as a section of a truncated slightly tapered cone having a relatively flat top 38 which merges into an elevated shoulder 39. Comparing also the median profile, Fig. 4, and the face view, Fig. 2, it will be seen that the shoulder 39 is parallel to, but offset from, the adjacent apex 32, and that it is in the same plane as the apices 32 and 35.

The outside bumps 37 merge into other spacers 41, having the same characteristics as the spacers 33 with respect to height, but which are oppositely inclined with respect thereto. The spacers 41 in turn merge into inside bumps 42. These are like the bumps 37, in that they are also truncated cones having tops 43 which merge into elevated shoulders 44 having the same height and substantially the same width as the apices 32 and 35 and the shoulders 39. The differences are that the bumps 42, adjacent the bumps 37, face in the opposite direction from the outside bumps 37, and they are of greater height, as will appear from inspection of Fig. 2, or from measurement of the profile, Fig. 6.

The pattern of spacers and inside bumps is then repeated, with the spacers being oppositely directed from the adjacent spacers, and the bumps also being oppositely directed from adjacent bumps along the length of the ribbon 30. In the illustrated core, and counting transversely or from face to face, six bumps are employed. The number of bumps may of course be varied, and also the inclination of the spacers. It has been found beneficial to make the bumps of such size, and to displace them to such extent that adjacent bumps overlap each other slightly in the transverse direction. This produces an air passage having a wavy or somewhat sinusoidal contour, thereby increasing the overall length of the air path in respect of core depth, and also causing the air to change direction repeatedly and have a more turbulent flow.

The opposite or interior surface of the ribbon 30 may be described by considering that a length of ribbon has been folded on itself to make a double inner, and then the water side surface—part (c) of Fig. 3, just described—has been lifted to expose such opposite surface. This will reveal portion (d) of Fig. 3. There are a number of similarities which may be briefly noted. Marginal apices 32a, and spacer apices 35a, 41a, etc., are of the same elevation, and therefore also define a narrow undulatory line lying in a single plane. The apices 32a, which are normal or perpendicular to the faces of the core, therefore are directly superimposed on each other when the ribbon is folded on itself, and the apices of the spacer sections contact and cross each other. This is illustrated by the broken line in part (d) of Fig. 3, which shows the trace of the interior surface of part (c).

The outside and inside bumps 37a and 42a are not depressed below the plane of the several apices, but in contradistinction to the water line surface, are elevated above it. The base of the bump 37, for example, merges into a narrow ledge 47 disposed in the same plane as the various apices, which in turn is contiguous with the bump 37a, as will appear from the profile of Fig. 4. Similarly, the bases of the inside bumps merge into ledges 48 which in turn are contiguous with the relatively elevated bumps 42a. Due to the

angularity of the spacers, the flanks of the inner bumps are slightly spaced, as shown by the clearance gaps 49 in Figs. 4 and 6. Hence, air may flow not only from face to face of the core in a plurality of separate paths, but also between the interior paths through the gaps 49. The projection of the interior bumps above the spacer apices, in connection with the intersection of the latter, provides for proper location of the superimposed ribbon during the course of assembly.

Referring again to the exterior or water line side of the ribbon 30, it will be noted, particularly from Fig. 2, that the exterior bumps 37, 42, are spaced from the water line ribbons 20, and that the outside bumps 37 have slightly greater clearance than the inside bumps. Contact with the water line is effected through the apices and shoulders which, as previously noted, are in the same plane. Due to the relatively wide areas of the portions 25, full line contact is assured from face to face, even though there may be some minor displacement of the "inner" ribbon 30 in its "outer" envelope. When the assembled core is held in its clamping frame for face dipping, the molten solder can thus flow by capillary attraction along the lines of contact, thereby providing strong joints of good heat transfer capacity. This is illustrated by the stippling in parts (a) and (c) of Fig. 3, which shows continuous bonding.

There is not, however, the same continuity of contact between the mating edges of the interior surfaces of the ribbon 30. As previously noted, the marginal apices 32a are in contact, as well as a small portion of the marginal spacer sections 35a, but contact is then interrupted, and is renewed when the next set of spacers cross each other. Accordingly, the solder penetrates only a limited extent in the joints between the interior surfaces, as the separation overcomes the force of capillary attraction. The interior surfaces are therefore adequately bonded along their margins, but solder which otherwise would flow into the joints is saved. This is a significant advantage in view of the comparative scarcity and cost of tin.

A further saving of solder is effected by spacing the exterior bumps 37, 42, from the water line ribbons 20. The extra depression of the marginal bumps 37 provides a safety measure against picking up solder from the bath, and also increases the area of the air passages at their entrances. Additionally, the equivalent of an increased amount of fin surface is also obtained, without increase in actual weight of metal. This may be ascribed to the concept that the flow of heat is from the water, through the ribbons 20, and into the ribbons 30 to their interior surfaces. Inasmuch as the exterior bumps 37, 42, are spaced from the ribbons 20, additional amounts of fin surface are available for contact with air, the pressure drop is decreased, and the air velocity correspondingly increased. All these factors contribute to increased B. t. u. capacity.

It is believed that the nature and purpose of the various parts of the core, and the relationships between them, have been fully explained, and therefore an extended summation is unnecessary. As just noted, the hot cooling liquid flows in a plurality of enclosed passageways or water lines, from end to end, while air flows transversely of the core, in paths defined by the exterior surfaces of the water lines and the spacing fin 30, and by the interior surfaces of the fins. The core

lends itself readily to established manufacturing practices, may be made of light weight sheet metal, and may be readily modified in its proportions to meet the requirements of specific applications. For example, in what are known as deep cores, such as those having a thickness of four or more inches, as well as the more conventional two or two and one-half inch cores, it may be expedient to break the continuity of contact between water lines and fin ribbons at the center of the core, without detrimental sacrifice of efficiency or strength.

While the invention has been described with reference to a single embodiment, it is to be understood that numerous modifications and variations may be made without departure from its principles, or its scope as set forth in the following claims.

I claim:

1. A radiator core comprising a plurality of pairs of imperforate water line ribbons joined along their marginal portions and spaced therebetween to provide water passages, and heat radiating fin ribbon interposed between said water passages, said fin ribbon having a generally zig-zag formation longitudinally thereof and formed transversely with bumps alternately projecting in opposite longitudinal directions, said bumps being arranged in a series of longitudinal rows interconnected transversely by oppositely inclined spacer sections having apices, said bumps on one face of the fin ribbon merging at their tops into elevated shoulders which lie in a common plane with the apices of the spacer sections and the marginal portions of the ribbon, said fin ribbon on said one face contacting adjacent water line ribbons in said common plane thereby to provide substantially full line contact between water line ribbon and fin ribbon from face to face of the core, the opposite face of the fin ribbon being in contact with a like face of a companion fin ribbon, said bumps on said first named one face being disposed in spaced relation to the water line ribbon.

2. A cellular radiator core of the multiple inner fin ribbon type comprising a plurality of pairs of imperforate water line ribbons joined along their margins and spaced therebetween to provide water passages, said water line ribbons having plane contact surfaces extending from said margins to the medial portion of the ribbons, said pairs of water line ribbons being spaced by multiple lengths of fin ribbon, said fin ribbon having a generally zig-zag formation longitudinally thereof comprising mutually inclined sides and apices, said fin ribbon further having longitudinally aligned rows of outside and inside bumps interconnected transversely by spacer sections, said spacer sections having apices alternately angularly inclined in opposite directions with respect to a line perpendicular to the faces of the core, the marginal apices and apices of the spacer sections, together with the transverse portion of the ribbon adjacent said bumps, lying in a common plane and defining an undulatory line therein and from face to face of the core, said bumps on one surface of the ribbon being depressed below said plane, said ribbons contacting the plane surfaces of the water line ribbons along said line and in said plane to provide substantially full line contact between the water line and fin ribbons, said fin ribbons mutually contacting each other on their opposite surfaces at the apices of the marginal portions and of the spacer sections, said bumps on said opposite sur-

faces being out of full contact with each other, whereby capillary flow of bonding solder can occur along said undulatory line for the length thereof and whereby capillary flow of solder between said opposite surfaces is limited substantially to the marginal portions of the ribbon.

3. A radiator core as set forth in claim 2, wherein the outside bumps are spaced from the water line ribbons a distance greater than the inside bumps.

4. A radiator core as set forth in claim 2, wherein the bumps on said opposite surfaces are spaced from each other a distance sufficient to provide air gaps therebetween.

5. A radiator core as set forth in claim 2, wherein the bumps on said opposite surfaces are elevated above the apices of the marginal and spacer sections.

6. A cellular radiator core comprising a plurality of pairs of imperforate water line ribbons joined to each other along their margins and spaced therebetween to provide water passages and multiple lengths of fin ribbon interposed between the water line ribbons in contact therewith along their exterior surfaces and in contact with each other along their interior surfaces, said water line ribbons having substantially continuous plane surfaces extending from face to face of the core, said fin ribbons having a generally zig-zag formation including oppositely inclined sides and apical crests, said crests lying substantially in a common plane, said apical

crests further including marginal portions normal to the core faces, spacer portions inclined thereto alternately in opposite directions, and shoulder portions normal to the core faces and connecting the spacer portions, thereby to impart an undulatory line contour to the several transverse crests of the ribbon, longitudinally aligned rows of bumps projecting from the inclined sides of the fin ribbon at the shoulder portions thereof, the bumps of each row alternately facing in opposite longitudinal directions, the bumps on the exterior surface of the fin ribbon being depressed with respect to the plane of said undulatory lines, said fin ribbon being in contact with the plane surfaces of the water line ribbon along the undulatory lines of said exterior surface and bonded thereto, said fin ribbons being in contact with each other along their interior surfaces at their marginal portions and spacer portions, the bumps on the interior surfaces being slightly spaced from each other.

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