

Feb. 20, 1962

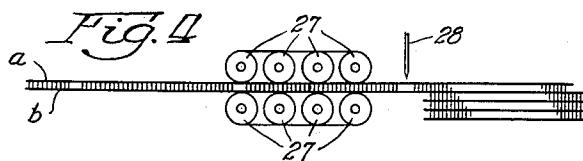
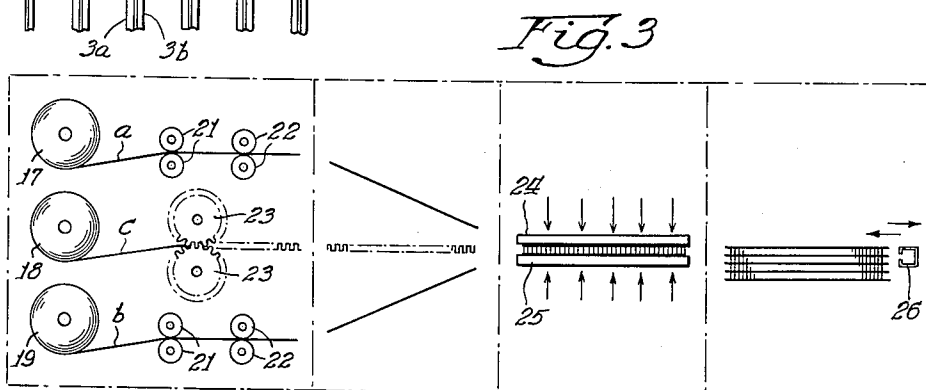
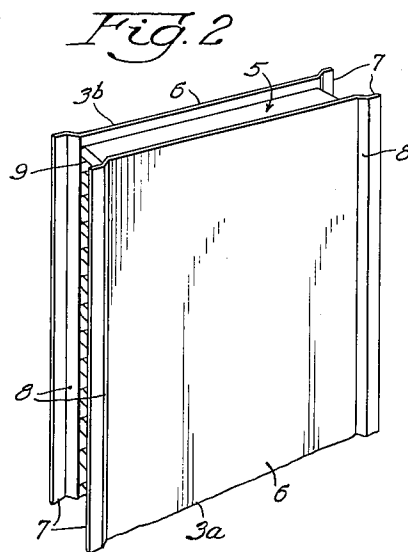
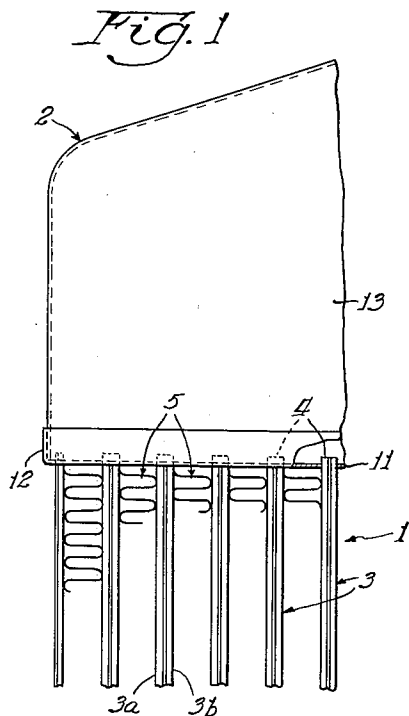
C. S. SIMPELAAR

3,021,804

METHOD OF FABRICATING HEAT EXCHANGERS

Filed Feb. 18, 1955

2 Sheets-Sheet 1



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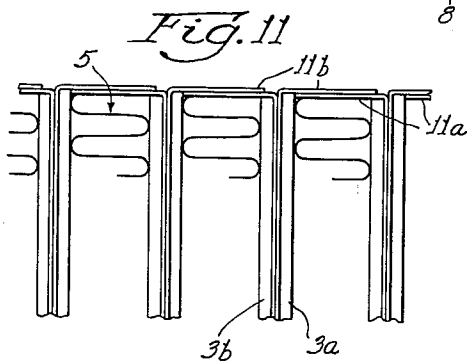
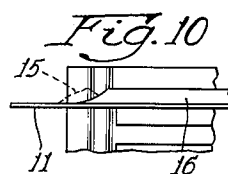
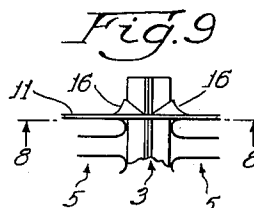
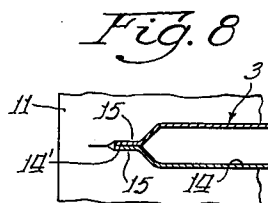
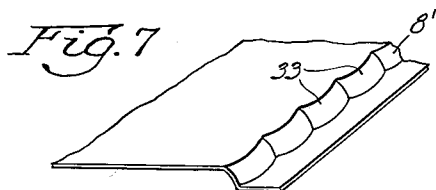
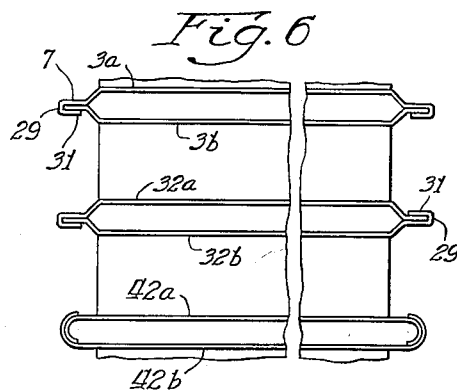
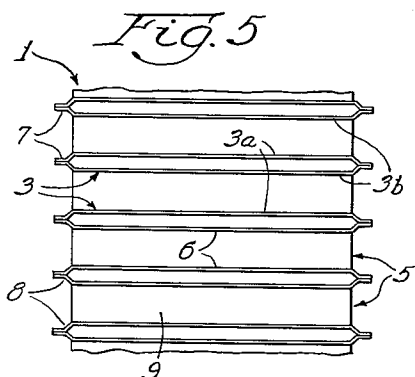
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METHOD OF FABRICATING HEAT EXCHANGERS

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2 Sheets-Sheet 2



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3,021,804

METHOD OF FABRICATING HEAT EXCHANGERS

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3 Claims. (Cl. 113-118)

The invention relates generally to heat exchangers, and more particularly to a novel heat exchange structure and method of making the same.

The invention is particularly applicable to heat exchangers of the type utilizing a series of tubular fluid conducting members having secondary heat transfer means associated therewith. Examples of this general type of exchanger are radiator cores presently utilized on water cooled combustion engines and the like. Radiators of the type commonly employed for this purpose embody a plurality of tubes which are assembled in parallel relation with a plurality of transversely extending fin elements, the latter usually being in sheet form. Radiators of this type are normally assembled by inserting preformed tubes through a plurality of aligned fin strips, a suitable jig normally being employed to facilitate the operation. Radiator cores have also been designed wherein preformed tubes are assembled with intermediate fin structures and the entire core bonded into an integral unit. I am also aware of the prior "honeycomb" type of radiator core wherein a plurality of preformed elements were assembled and subsequently simultaneously bonded into an integral structure, the elements forming the fluid conducting passages and intermediate air passages.

All of these prior structures contain inherent limitations, both in the article itself and in the manufacturing techniques associated therewith. One important limitation with respect to the manufacture of these types of cores is the difficulty of producing the article by machine assembly, substantially all of these types requiring manual assembly operations followed by a bonding operation which simultaneously bonds all of the elements together, such bonding operations usually taking the form of a molten salt bath or an oven baking operation, which requires additional handling of the assemblies. A further limitation in the manufacture of radiator cores of this type is the necessity of employing comparatively costly fin dies together with associated die maintenance, and inability to achieve any material degree in flexibility or variability in operational characteristics of exchangers utilizing fins produced from a single die as such variability is limited to variations in fin spacing. Another limitation is that imposed on the materials employed, often necessitating the use of heavier materials to insure satisfactory fabrication than would be required to obtain the desired operational characteristics in the final radiator core. For example, the fin thickness is dependent upon the ability to fabricate the tubes therewith rather than upon functional heat exchange requirements.

The present invention is directed to a heat exchange structure which is of particular use in radiator cores and the like, and to a novel method of making the same in which the above limitations and disadvantages are materially reduced if not eliminated. Consequently the invention has among its objects the production of a novel heat exchange structure and method of producing the same whereby maximum automatic machine production may be achieved together with a considerable reduction in costly tooling as well as handling, and the utilization of lighter and cheaper materials, resulting in a considerable reduction in the cost of manufacture of such heat exchangers.

Another object of the invention is the production of a novel heat exchange structure which is suitable for high

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speed automatic assembly and which is so designed that considerable latitude is achieved in operational factors whereby the characteristics of the exchangers may be readily varied with for the most part relatively minor adjustment of the assembling machine, at the same time producing a radiator core requiring less maintenance and in which repairs may be readily and easily affected.

Many other objects and advantages of the construction herein shown and described will be obvious to those skilled in the art from the disclosure herein given.

To this end my invention consists in the novel construction, arrangement and combination of parts herein shown and described, and more particularly pointed out in the claims.

In the drawings, wherein like reference characters indicate like or corresponding parts:

FIG. 1 is a front elevational view of a portion of a radiator core and heater assembly embodying the present invention;

FIG. 2 is a perspective view of a portion of a sub-assembly constructed in accordance with the present invention;

FIG. 3 is a diagrammatic view of the steps or stations which may be employed in fabricating the exchanger illustrated in FIG. 1, designed for intermittent operation;

FIG. 4 illustrates a modified arrangement of the assembly and bonding steps illustrated in FIG. 3, designed for continuous operation;

FIG. 5 is a top plan view of a core structure of the type illustrated in FIGS. 1 and 2;

FIG. 6 is a view similar to FIG. 5 in a slightly modified form of construction;

FIG. 7 is a perspective view of a portion of one of the tube halves illustrating one way in which additional reinforcement of the tube structure may be achieved;

FIG. 8 is a bottom view of an assembled tube and a portion of a heater structure illustrating how the latter may be secured to the tube, taken approximately on the line 8-8 of FIG. 9;

FIG. 9 is a front elevational view of a tube and portion of the header plate illustrated in FIG. 8;

FIG. 10 is a side elevational view of the structure illustrated in FIGS. 8 and 9; and

FIG. 11 is a front elevational view of a modified core structure wherein the tube halves are constructed to form header means.

The invention contemplates the fabrication of a plurality of sub-assemblies each made up of secondary heat transfer means and elements of the fluid conducting members, with each sub-assembly being suitably bonded or otherwise united into an integral unit, and subsequently assembled with like sub-assemblies, adjacent sub-assemblies being bonded or otherwise connected to each other to form a final integral core assembly. In the embodiment illustrated, each sub-assembly may comprise a secondary heat transfer structure, illustrated in the drawings as being of the corrugated or serpentine type, in combination with a pair of halves of fluid conducting tubes, the respective halves being assembled at opposite sides of the secondary heat transfer structure, following which the sub-assembly is suitably united as an integral unit. Like sub-assemblies may then be assembled with cooperable tube halves in abutting relation and each pair of cooperating tube halves secured together to form a fluid conducting tube, which operation at the same time completes the assembly thereof in the radiator core. Obviously operations of the type involved in such a method of assembly readily adapts itself to high speed automatic production techniques so that it would be both possible and practical to produce a machine which would receive rolls of stock at one end and deliver assembled and bonded unitary heat exchanger cores at the output end.

Referring to the drawings and more particularly to FIG. 1, the reference numeral indicates generally a portion of a heat exchange radiator core of the automotive type operatively connected to a header structure indicated generally by the numeral 2. The core 1 comprises a plurality of hollow fluid conducting tubes 3, having their upper ends 4 communicating with the interior of the header 2, the lower ends of the tubes normally being connected to a similar header, in the same manner as radiators presently employed with combustion engines and the like. Extending between each adjacent pair of tubes 3 is a secondary heat transfer structure indicated generally by the numeral 5 which, as illustrated in the drawings may take the form of a corrugated or serpentine fin structure or section formed by alternately bending a sheet of material back and forth, the fin structure being suitably bonded or secured to the side walls of the tube in heat transfer relationship therewith. Thus, fluid may flow from one header through the conducting tubes 3 to a second header while air or other medium may flow between tubes and corrugations of the fin structure.

In the embodiment of the invention illustrated in FIGS. 1, 2, and 5, the tubular fluid conducting members 3 are constructed in halves 3a and 3b, each half being similarly shaped but reversely positioned and, as illustrated in FIGS. 2 and 5, the halves may be formed with a planar intermediate section 6 and offset peripheral flanges 7, each pair of flanges 7 of a tube half lying in a common plane extending substantially parallel to the plane of the portion 6, with the flanges connected to the latter by intermediate transversely extending portions 8. As illustrated in FIG. 5, the halves 3a and 3b may be assembled with their flanges in abutting relation to form a fluid conducting passage between the intermediate portions 6, abutting pairs of flanges being suitably secured together in fluid tight relationship by bonding, welding or other suitable means. Each of the fin sections 5 comprises a plurality of transversely extending fins 9, adjacent fins being alternately connected at opposite ends thereof, with the connecting portions engaged with and secured to the exterior faces of the respective conducting tubes 3.

The tubes 3 may be secured to the header 2 by any suitable means, one example of which is illustrated in FIGS. 8 to 10. In this construction the header plate 11, which is illustrated in FIG. 1, may be provided with peripheral upstanding flanges 12 to which the header tank 13 may be secured, and is provided with a plurality of openings 14 of a size to receive a fluid conducting tube 3, the opposite ends of the opening 14 being provided with slits 14', only one of which is illustrated in FIG. 8, with the wing portions 15 at each side of the slit 14' being bent out of the plane of the plate 11 as illustrated in dotted lines in FIG. 10. The tube-receiving opening 14 is preferably formed with oppositely disposed flanges 16 adapted to be positioned in engagement with the outer face of the portion 6 of each tube, such construction being similar to that heretofore employed. After the tubes have been inserted in the header plate, the wings 15 may be forced substantially into the plane of the sheet thereby firmly engaging the flanges 7 and effectively closing the extreme end of the slit 14, whereby upon bonding an efficient fluid tight, mechanically located joint is produced.

Other header means may also be employed which may include elements formed on the core structure, such a construction being illustrated in FIG. 11, wherein the tube halves 3a and 3b may be provided with overlapping flanges 11a and 11b at the ends of the tubes, with the flanges extending transversely outwardly from each tube half into overlapped relation and bonded together, thus sealing the end portions of the intermediate spaces between the tubes occupied by the corrugated fin sections. Suitable elements to complete the header assembly could

then be attached to the header structure formed by the flanges 11.

Radiator cores of the general type above described, utilizing a plurality of tubes spaced by secondary heat transfer surfaces, normally are produced by fabricating a plurality of planar type fin elements which are apertured to receive previously formed fluid conducting tubes, the latter being assembled in the fins and subsequently bonded thereto. In the present instance radiator core structures of the type illustrated may be fabricated by means of a novel method whereby the core may be produced substantially entirely by machinery which may be automatic in operation, so that by utilization of such method it would be possible to feed stock into a machine and turn out assembled cores therefrom without any manual handling of the core.

The invention generally contemplates the utilization of a novel method of fabrication wherein a plurality of sub-assemblies are fabricated into integral units, such units being subsequently assembled or stacked and united to form the fluid conducting tubes and the completed radiator core. With respect to the structure illustrated in FIG. 1, the invention contemplates the fabrication of a plurality of such assemblies each of which comprises a pair of tube halves 3a and 3b and a secondary heat transfer fin section 5. However, as illustrated in FIG. 2, the tube halves 3a and 3b are not assembled to form a single tube but are disposed on opposite sides of the heat transfer section 5, with the flanges 7 on oppositely disposed halves being transversely aligned as illustrated in FIG. 5. Such sub-assembly is then suitably united to form an integral structure by bonding or other suitable means. A plurality of sub-assemblies thus produced may be assembled with oppositely disposed halves 3a and 3b positioned with their flanges 7 in opposed abutting relation and abutting flanges united by welding or other suitable means to form fluid-tight joints, such final bonding operation completing the tubes 3 and forming the core structure into a unitary assembly.

FIGS. 3 and 4 illustrated practical applications of the method described to the assembly of radiator cores or the like and obviously could be accomplished by comparatively simple machinery. Referring to FIG. 3, such an assembly could be roughly divided into five general operations. The first operation may be termed a feeding operation wherein suitable strip material a, b and c could be fed from rolls 17, 18 and 19 to a forming mechanism. Strips a and b may be formed into tube halves by processing through suitable means such as pairs of forming rolls 21 and 22 to produce the offset flange portions 7. Similarly the intermediate strip c from which the heat transfer fins are to be formed may be fed between suitable means, such as forming rolls 23 to produce a corrugated structure.

In the third operation the strips a, b and c may be suitably processed to prepare the same for bonding. This operation may include all preparations for bonding such as abrading and fluxing contact surfaces and in some cases it may be desirable to tin portions of elements to be bonded.

The fourth general operation would be that of uniting the intermediate fin strip c with the tube halves or strips d and b by the application of pressure and heat, diagrammatically illustrated by members 24 and 25 adapted to exert pressure on the sub-assembly and simultaneously heat the same to bonding temperature. If desired, following the heating of the assembly, cooling means, as for example steam or air may also be provided to shorten the cycle of operation.

The final assembly operation of the core may comprise stacking the unitary sub-assemblies one upon the other with the flanges 7 of adjacent tube halves in aligned abutting relation, following which such abutting flanges may be united in fluid-tight relation by bonding, welding or

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other suitable means, diagrammatically illustrated in FIG. 3 by a C-shaped welding member 26 which may be constructed to be reciprocated along the face of the assembled core to weld the flanges 7 in a fluid-tight relation. Obviously, one of the welders 26 would be positioned at each face of the core whereby both pairs of flanges of each tube may be simultaneously united. In such an operation, as each new sub-assembly is placed on top of the core structure, the latter may be moved downwardly to accommodate the next sub-assembly, with the welding or bonding operation taking place during each cycle of operation.

It will be apparent that the method of assembly illustrated in FIG. 3 involves intermittent operation, the elements being intermittently advanced to the bonding operation for securing the tube halves to the fin structure, with the elements being stationary during such bonding operation, and upon completion of the latter again advanced from the bonding operation to the final stacking operation.

FIG. 4 illustrates the application of the present invention to a continuous assembly operation and may utilize the first three operations described with respect to FIG. 3, with the exception that the strips *a* and *b* would not be cut into predetermined lengths but maintained in continuous form, such continuous strips, following the preparation for bonding, being brought into superimposed relation and moved through a bonding operation illustrated as comprising a plurality of rollers 27 which may apply pressure to the sub-assembly, heat being simultaneously suitably applied to bring the elements to bonding temperature. Likewise suitable means may be provided for cooling the bonded assembly subsequent to the heating of the structure to bonding temperature. Following the bonding of the strips and fin structure, the continuous sub-assembly may be severed at suitable intervals by a cutter indicated diagrammatically in FIG. 4 by the numeral 28. If desired, the corrugated fin structures or sections may be cut into fixed lengths prior to the assembly of the two strips therewith, with the individual fin sections being suitably fed between the strips whereby a space will be provided between adjacent fin sections, so that when the continuous strips are severed by the cutter 28, the strips *a* and *b* will extend beyond the ends of the fin sections, facilitating the assembly of the tube ends of the completed core with a header structure.

It will be noted that in both FIGS. 3 and 4, the strips and fin sections are formed into unitary sub-assemblies each comprising a pair of tube halves connected to the intermediate fin section, and following the fabrication of the sub-assemblies the latter are assembled into a core structure and united along the edges of respective cooperating tube halves to form a unitary core having a plurality of spaced fluid conducting tubes with secondary heat transfer surfaces extending therebetween and secured thereto in heat transfer relation.

It will also be apparent that in the utilization of the present method, the fin sections may be bonded to the tube halves under pressure resulting in highly efficient bonding between the fin structure and the ultimate fluid conducting tubes, with the surface to be bonded being readily accessible for preparatory operations such as cleaning and fluxing, the method also enabling the use of adequate pressure to insure primary metal to metal contact between the bonded elements, thereby substantially achieving 100% bonding. Likewise the edge bonding or uniting of the tube halves insures satisfactory production of fluid-tight joints, at the same time enabling easy verification of the bonding on individual elements.

In some cases it may be desirable to mechanically interlock each pair of tube halves instead of merely bonding the same as illustrated in FIGS. 1, 2 and 5, and examples of interlocked structures are illustrated in FIG. 6, wherein the flanges 7 on the upper tube half 3a may be provided with transversely extending portions 29 which,

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following assembly with a cooperating tube half 3b, may be crimped around the flanges 7 of the latter as indicated at 31. In some cases it may be desirable to form the portions 29 and 31 on one edge of each tube half as illustrated on the tube halves 32a and 32b in which case identical tube halves could be employed and reversed to enable assembly. Similarly the edges could be formed with curved nesting portions as illustrated in FIG. 6 on the halves 42a and 42b.

In some cases it may be desirable to stiffen the tube halves, in which case the structure may be suitably formed, as for example, the intermediate offset portions 8' illustrated in FIG. 7 could be suitably contoured with a series of beads or ridges 33 which would add rigidity to the structure.

Obviously, the present method may be utilized with various modifications in the structure of the core, and particularly in connection with the fabrication of the conducting tubes and the manner in which the abutting edges of elements to be bonded together may be fabricated to achieve desired results. For example, the longitudinal edges of the tube halves could be constructed in an overlapped arrangement similar to the ends of the tubes illustrated in FIG. 11, the flanges if desired being provided with interlocking portions whereby the tube halves could be snapped or nested together, in like manner the longitudinal tube edges could be suitably corrugated to provide a longitudinal interlock.

It will be noted that I have provided a novel core structure and method of fabricating the same which possesses a considerable number of advantages over previous methods and designs and by means of which equivalent or better performance over other types of cores could be achieved, with a reduction in cost both as to material and labor. Furthermore it is believed obvious that the present invention provides a variability in performance factors which would permit a closer inexpensive approach to the optimum for specific core requirements than is currently possible with core structures constructed by present methods. For example, by simple adjustments the fin width or distance between tubes may be obtained by adjustment of the centers of the forming rolls 23, the number of fins readily controlled by varying the fin pitch, depth of core by change in stack width and simple adjustments and variations in fin characteristics by suitable contouring accomplished by modifications in the fin rolling structure.

In addition to providing a novel core structure and method of fabricating, I have also provided a simple form of core fabricating machine which comprises basically five stations including structures providing for the operations as disclosed and described with reference to FIGS. 3 and 4. The core fabricating machine preferably comprises a feeding station incorporating three rolls of stock with their feed rolls providing material for the two tube halves and for the fin. At the forming station, mechanism is provided so that in the operation thereof, the tube halves are rolled to the necessary configuration, and the corrugated fin rolls with their attendant gathering and sizing apparatus provide the fin element. The third station, at which the bonding operation takes place there is provided apparatus for abrading and fluxing contact surfaces. At this station the edges of the fin loops may be tinned particularly where subsequent operations would not require tinning of the tube halves. At the fourth or bonding and cooling station, the basic core element comprising the fin and tube halves is soldered or otherwise bonded under pressure with suitable apparatus to secure complete contact. This station would also incorporate a cooling device such as multiple steam or air jets to cool the fin element while under pressure with suitable apparatus. At the fifth or core assembly station, the fin and tube elements are brought into alignment into a complete assembly while the edges of the tubes are successively bonded by automatic or semi-automatic appa-

ratus for welding, soldering, or other suitable devices for bonding with other methods.

The operation of this automatic core fabricating machine may either be constructed for intermittent operation providing individual elements of required length successively carried through the various stations or the operation may be considered as a completely continuous one with the fin elements only severed at proper lengths and providing a gap, and the tube halves remaining as a continuous strip until the final automatic cut-off operation prior to assembly into the core. This latter method of fabricating and apparatus therefor, provides for continuous control of the stock thereby simplifying the feed-through mechanism.

It is also obvious that the improved heat exchanger core of this invention provides an improved heat exchanger core structure over present forms of fin and tube design which cannot be fabricated linearly. It is also obvious that this improved core construction overcomes the previous limitations of prior art core structures wherein the previous limitations were: (1) minimum limitation of fin thickness for satisfactory fabrication; (2) difficulty of adaptation to machine assembly; (3) difficulty of adaptation to use of cheaper materials, such as aluminum fins; (4) susceptibility to incomplete bonding and difficulty of its control; (5) costly fin dies and die maintenance; (6) variability of performance factors from a single die, primarily limited to modification in fin spacing only.

It is also evident that I have disclosed a fin tube element which may be assembled into completed core elements using cheaper fin material and fabricated from very thin material or foil-like heat exchange material preferably within the range of thickness from 0.002" to 0.005" for forming the tube halves and material within the range of thickness from 0.002" to 0.004" for forming the corrugated fin elements.

It is also evident that I have disclosed a fin tube element which may be made from brass or copper material or aluminum material, and which also would lend itself readily to the use of aluminum fins soldered to brass or copper tube sides because of the easy access to the contacting surfaces for bonding preparations and the ability to individually pressurize bond during the soldering operation. This is an important feature with regard to the development of the application of aluminum fins to automotive radiators. It is also within the scope of this invention that the construction of the core and the apparatus for producing the core within this disclosure is equally applicable for the production of an all aluminum core.

It is also obvious that there has been disclosed apparatus for producing a fin tube element and assembled heat exchange core structure wherein by simple variation the distance between tubes may be adjusted by adjustment of roll centers and fin widths may be adjusted equally as readily. The apparatus may provide for variation in fin pitch by simple adjustment of the spacing device. Variation in fin width or depth of core is readily provided for by use of proper width stock and simple adjustments. It is also evident that the fin and tube parts may be produced at a high rate of speed and that the apparatus is adapted for automatic production. Except for complicated fin contours or slit fins, the fin tools would comprise relatively simple rolls.

Although simple forms of complementally formed edges have been disclosed for bonding the tube halves together, it is within the scope of the invention that other forms of complementally formed edges of the two halves may be used which may be formed to snap together or to nest together, or they may be formed with tube edges provided with a corrugated or stepped arrangement, all of which may be readily bonded together.

I have also disclosed a simple construction for providing reinforced edges for tube halves which may be rolled

thereon or otherwise fabricated from the very thin or foil-like material from which the tube halves are fabricated.

I have also disclosed simple constructions and methods of headering in which the fin tube halves are assembled through a header plate or in which the fin tube halves may be fabricated to form an integral header plate from the ends of the fin tube halves.

Although I have particularly disclosed a fin tube element made from fin tube halves bonded to a corrugated or undulating fin element, it is to be understood that it is within the scope of the invention that a fin tube element can be fabricated from continuous fin material either longitudinally or transverse with respect to the longitudinal axis of the tube halves as they are continuously formed.

Having thus described my invention, it is obvious that various immaterial modifications may be made in the same without departing from the spirit of my invention; hence, I do not wish to be understood as limiting myself to the exact form, construction, arrangement and combination of parts herein shown and described or uses mentioned.

What I claim as new and desire to secure by Letters Patent is:

1. The method of making a heat exchanger including fluid conducting members of narrow width and with flat walls of substantial depth comprising the steps of simultaneously advancing and forming a pair of strips to provide a pair of heat exchanger walls, said heat exchanger walls formed as recessed flat parallel walls and having longitudinally peripheral portions formed to mate with like portions of cooperable walls for providing fluid conducting members of narrow width and with flat walls, simultaneously advancing and forming a third strip as said pair of strips are simultaneously advanced and formed to provide a secondary heat transfer structure, assembling said walls with said secondary structure disposed therebetween and the longitudinal peripheral portions of the walls extending transversely outwardly therefrom and laterally beyond the corresponding edges of the secondary structure for mating with corresponding portions of like walls, applying pressure to the intermediate portions of the recessed flat parallel walls of the sub-assembly thus formed to place the portions of the secondary structure abutting said recessed flat parallel walls in intimate contact therewith and maintaining the areas of the respective walls, coextensive with the secondary structure, in spaced parallel relation, bonding said recessed flat parallel walls to the abutting portions of the secondary structure while the latter portions are maintained in intimate contact with said recessed flat parallel walls, maintaining such pressure until completion of the bonding operation, assembling the unitary sub-assembly thus formed with like unitary sub-assemblies with adjacent recessed flat parallel walls of adjoining sub-assemblies having their corresponding longitudinally extending peripheral portions in mating engagement and spaced laterally outward from the secondary structures, and connecting such mating portions of adjacent recessed flat parallel walls, while maintaining the original bonded relation between the respective recessed flat parallel walls and the secondary structures substantially unchanged, to form a unitary heat exchange structure with each pair of united heat exchanger walls forming a fluid conducting member having narrow width and recessed flat parallel walls, and each adjacent pair of fluid conducting members being connected by a respective intermediate heat transfer element.

2. The method of making a heat exchanger comprising the steps of simultaneously intermittently advancing a pair of spaced strips of material and an intermediate strip of material, forming said strips to provide a pair of heat exchanger walls having longitudinally peripheral portions formed to mate with like portions of cooperable walls, and a secondary heat transfer structure successively severing said strips into corresponding wall and secondary struc-

ture sections, advancing said wall and secondary structure sections to bring said wall sections into engagement with the secondary structure section with the longitudinal peripheral portions of the wall sections extending transversely outwardly therefrom and laterally beyond the corresponding edges of the secondary structure section for mating with corresponding portions of like wall sections, applying pressure to the intermediate portions of the wall sections of the sub-assembly thus formed to place the portions of the secondary structure section abutting said wall sections in intimate contact therewith and maintaining the areas of the respective wall sections coextensive with the secondary structure section, in spaced parallel relation, bonding said wall sections to the abutting portions of the secondary structure section while the latter portions are maintained in intimate contact with said wall sections, maintaining such pressure until completion of the bonding operation, advancing the sub-assembly thus formed into a stacked relation with a like sub-assembly with the adjacent walls of such sub-assembly having their corresponding longitudinally extending peripheral portions in mating engagement and spaced laterally outward from the secondary structures, connecting such mating portions of adjacent walls, while maintaining the original bonded relation between the respective walls and the secondary structures substantially unchanged, moving the assembly thus formed transversely relative to the advancing direction to position to similarly receive a following sub-assembly, and similarly joining advancing mating portions of a sub-assembly so received with the adjacent corresponding portions of the assembly, to form a unitary heat exchange structure with each pair of united walls forming a fluid conducting member having flat parallel walls, and each adjacent pair of fluid conducting members being connected by a respective intermediate heat transfer structure.

3. The method of making a heat exchanger comprising the steps of simultaneously continuously advancing a pair of spaced strips of material and an intermediate strip of material, forming said strips, while advancing, to provide a pair of heat exchanger walls having longitudinally peripheral portions formed to mate with like portions of cooperable walls, and a secondary heat transfer structure, advancing said wall strips and secondary structure strip at a uniform rate to bring said wall strips into engagement with the secondary structure strips with the longitudinal peripheral portions of the wall strips extending transversely outwardly therefrom and laterally beyond the corresponding edges of the secondary structure strip for mating with corresponding portions of like walls, applying pressure to the intermediate portions of the wall strips of the advancing sub-assembly thus formed to place the portions of the secondary structure strip abutting said wall strips in intimate contact therewith and maintaining the areas of the respective wall strips coextensive with the

secondary structure strip, in spaced parallel relation, bonding said wall strips to the abutting portions of the secondary structure strip while the latter portions are maintained in intimate contact with said wall strips, maintaining such pressure until completion of the bonding operation, successively severing the advancing unitary sub-assembly thus formed into a unitary sub-unit, advancing such a sub-unit into a stacked relation with a like sub-unit with the adjacent walls of such sub-units having their corresponding longitudinally extending peripheral portions in mating engagement and spaced laterally outward from the secondary structures, connecting such mating portions of adjacent walls, while maintaining the original bonded relation between the respective walls and the secondary structures substantially unchanged, moving the assembly thus formed transversely relative to the advancing direction to a position to similarly receive a following sub-unit, and similarly joining adjacent mating portions of a sub-unit so received with the adjacent corresponding portions of the assembly, to form a unitary heat exchange structure with each pair of united walls forming a fluid conducting member having flat parallel walls, and each adjacent pair of fluid conducting members being connected by a respective intermediate heat transfer structure.

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