Oct. 12, 1965 | D. M. DONALDSON | 3,211,118

HEAT EXCHANGER

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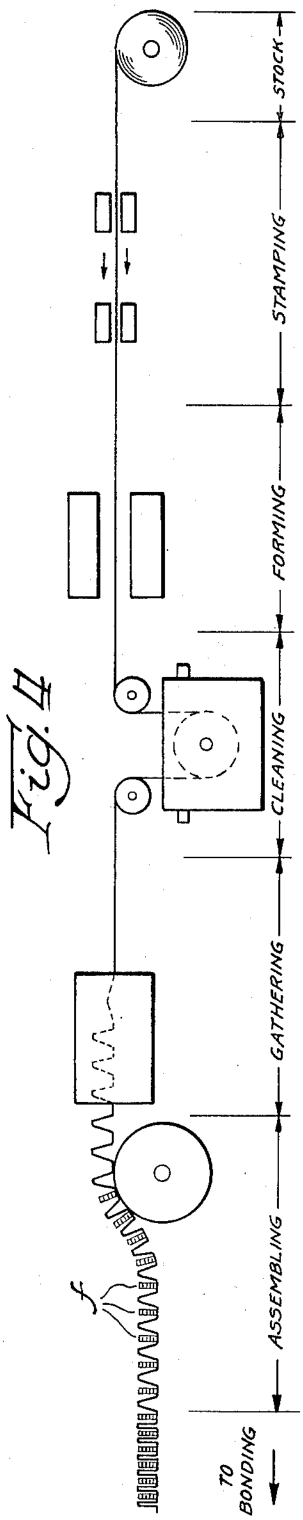

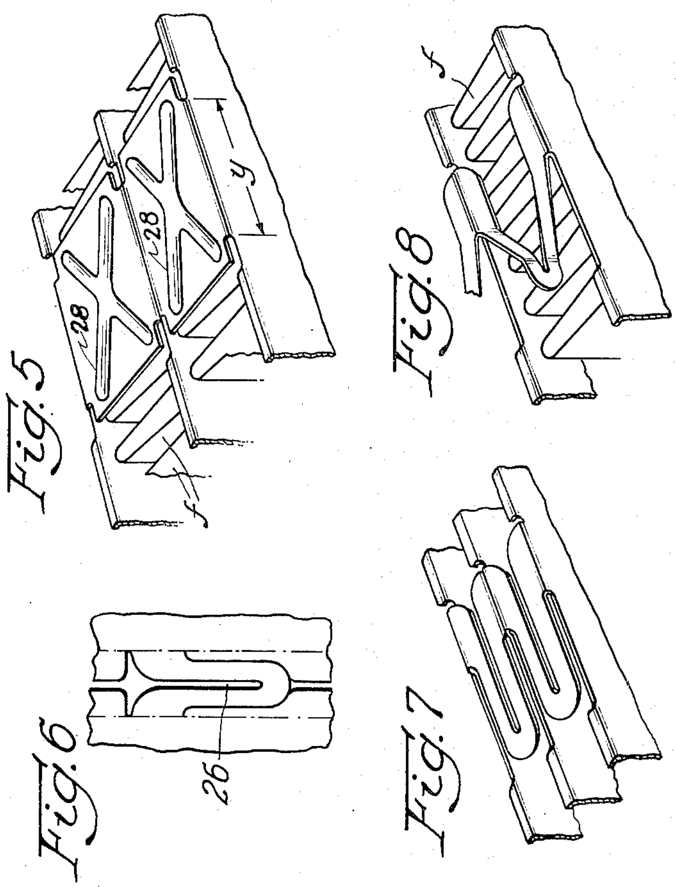

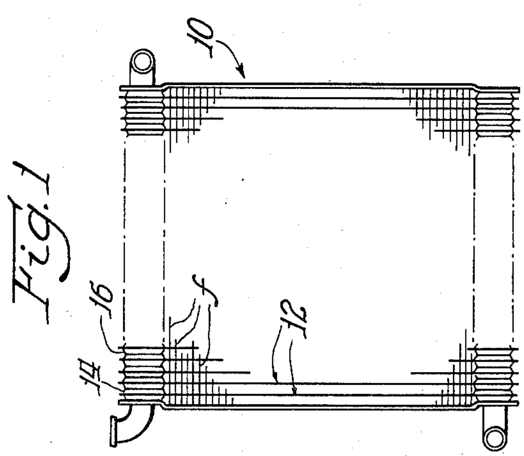

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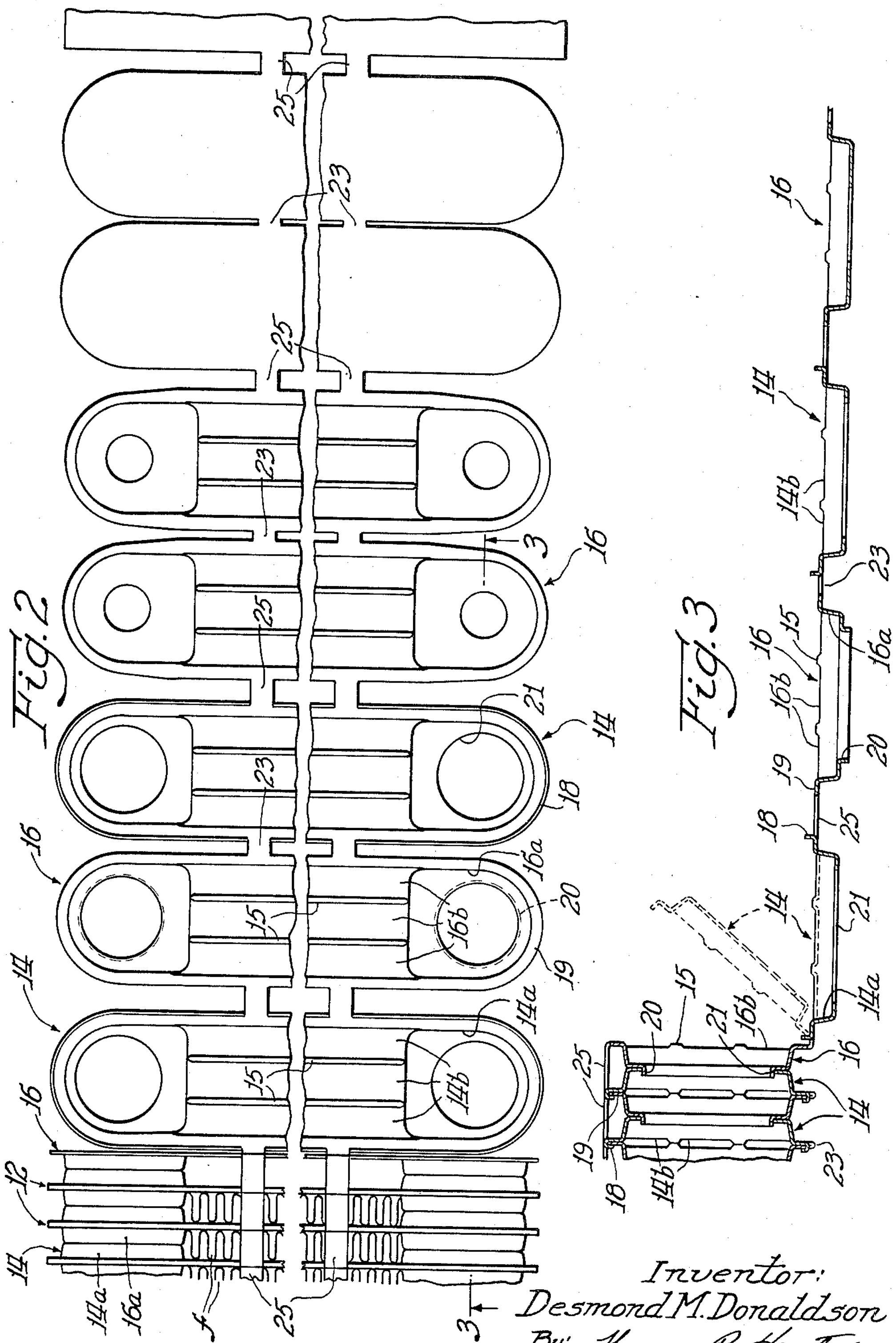

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3,211,118
HEAT EXCHANGER

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This invention relates in general to heat exchangers and more particularly to radiators suitable for use in automotive vehicles, for example.

It is a principal object of the present invention to provide an improved method of manufacturing a heat exchanger core assembly, such method being readily adapted to automated techniques with corresponding labor and cost saving advantages.

Another object of the invention is to provide an improved method of forming substantially the entire radiator core from a continuous strip of metal stock.

Another object of the invention is to provide an improved, low cost radiator manufactured in accordance with the aforementioned method.

Other objects and advantages will be apparent from the following detailed description taken in connection with the appended drawings wherein:

FIGURE 1 is a partial view of a radiator constructed in accordance with the principles of the present invention;

FIGURE 2 is a view illustrating the radiator in various stages of the manufacturing process;

FIGURE 3 is a view taken generally along section lines 3—3 of FIGURE 2;

FIGURE 4 is a diagrammatic process layout;

FIGURE 5 is an isometric view illustrating a design of the tie members connecting adjacent cooling elements together;

FIGURE 6 is a plan view of one embodiment of a tie portion subsequent to the initial stamping operation;

FIGURE 7 is a view of the tie portion subsequent to bending the individual cooling elements; and

FIGURE 8 is a view of the tie element illustrated in FIGURES 6 and 7 in an expanded position.

Radiators made in accordance with the present invention comprise a plurality of hollow cooling elements each having apertures adjacent the ends thereof, said cooling elements being so arranged to permit fluid to flow from one element to an adjacent element. The apertures are positioned in registered, generally coaxial alignment so that the sets of apertures provide a fluid inlet and outlet respectively. The fluid enters one set of fluidly interconnected apertures, flows through said hollow cooling elements and is withdrawn from an outlet header or manifold connected with the other set of apertures.

Referring now to FIGURE 1, there is illustrated a radiator **10** comprising a plurality of hollow cooling elements **12** formed by a pair of elongated, complementary plates or panels **14**, **16** respectively having their edges joined in sealed relationship. Each cooling element is provided with a pair of circular apertures and has a dished-out portion **14***a*, **16***a*, sometimes referred to as a drawn cup, adjacent each end thereof and an elongated intermediate portion **14***b*, **16***b* which is preferably provided with a series of reinforcing ribs **15** extending lengthwise along said plates. It will be noted that one plate **14** of each pair forming an individual cooling element is provided with lip **18** or flange extending upwardly for a short distance from the plane of said plate; and the other said plate **16** has a complementary unflanged edge **19** adapted to be received within said lip. This arrangement greatly facilitates the connection of said elements together by brazing or some other suitable method. A preferred material of construction is aluminum or aluminum alloy in which case any well known aluminum silicon brazing alloy may be employed to obtain a dependable, watertight seal.

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The plate members **16** also include a circular flange **20** extending from said plate and surrounding each of the apertures at the ends thereof. When the cooling elements are assembled, the aperture flanges **20** are adapted to be received within the unflanged apertures **21** of an adjacent cooling element to form a fluid transfer connection between adjacent cooling elements.

Referring now to FIGURES 2 and 3, the strip stock, preferably stored in a coil or other convenient form, is intermittently fed to a stamping section which forms the strip into a plurality of blanks from which the plates are fabricated. The rough cut blanks, as seen in FIGURE 2, are formed in pairs. Each individual plate of each pair is connected together by a short integral strip or web **23** at spaced intervals along its length. The blanks are also formed with small apertures adjacent each end thereof at substantially the same position. Each pair of blanks is interconnected by a slightly longer web **25** to an adjacent pair of plates at spaced locations along its length, the latter forming tie elements which are adapted to join, in spaced relationship, each of the individual cooling elements formed from a complementary pair of plates. The blanks are then delivered to a forming section wherein the end portions of each plate are drawn to form the concave or dished-out portions adjacent each end. The next step is the formation of the apertures with proper diameter and also forming the upstanding flanges on the edges of alternate plates and around the apertures of said alternate plates. Next, the plates are trimmed to remove burrs or any excess material from the edges or around the apertures and then are delivered to a cleaning section wherein they are preconditioned for subsequent bonding steps. As the plates emerge from the cleaning section they pass into the folding mechanism which bends each element in opposite directions alternately as they are fed from the trimming section. If desired, secondary heat exchange means in the form of a corrugated fin *f* may be inserted between each cooling element as formed. The resulting structure is in the form of a plurality of parallel stacked, hollow cooling elements interconnected by narrow ties. The width dimension of the ties is nominal as compared to the over-all width of the heat exchanger.

The folded sections **14**, **16** fit together such that the drawn cup portions **14***a*, **16***a* of the respective elements form a header portion of the heat exchanger and intermediate portions **14***b*, **16***b* of the respective elements form tube portions which extend between the header portions. The reinforcing ribs **15** in each of the intermediate portions **14***b*, **16***b* preferably extend toward each other such that they divide the respective intermediate portions into a plurality of separate flow passages each of which extends intermediate the header portions.

In order to economically employ the material with minimum waste, the tie elements may be formed in the manner shown in FIGURE 6. In this embodiment, each tie element is initially formed in a serpentine configuration such as, for example, the shape of a U the legs of which are separated by a slot **26** between adjacent fin plates. When the plates are expanded, as indicated in FIGURE 7, the resultant structure so formed is substantially the same as that disclosed in FIGURE 2, however the material removed from the elongated strip between the individual sections is greatly reduced.

A third embodiment illustrated in FIGURE 5 comprises tie elements having a reduced cross section *y* at the fold to facilitate bending of the ties with respect to the plates. If desired, a stiffening rib in the shape of a cross

28 or some equivalent design may be formed in each tie element to achieve greater rigidity and reduce flexing during the assembly procedure.

Manifestly, the construction as shown and described is capable of some additional modification and such modification as may be construed to fall within the scope and meaning of the appended claims is also considered to be within the spirit and intent of the invention.

I claim:

1. A method of manufacturing a heat exchanger from a continuous elongated strip of thin metal stock comprising the steps of:

(1) forming a plurality of pairs of elongated elements having a major dimension transverse with respect to said strip with expansible tie elements extending therebetween;

(2) forming a complementary face and a complementary back on each of said elements;

(3) folding said elements in a manner such that said elements are positioned face to face in pairs with adjacent pairs positioned back to back with said tie elements extending between said elements;

(4) expanding said tie elements to increase the spacing of said elements; and

(5) bonding said folded elements to form an integral heat exchanger.

2. A method of manufacturing a heat exchanger from a continuous strip of thin metal stock comprising the steps of forming a plurality of pairs of elongated elements having a major dimension transverse with respect to said strip with tie elements having a width substantially less than the width of said strip extending therebetween; forming a complementary face and a complementary back on each of said elements; folding said elements in a manner such that the elements of each pair are positioned in face to face relation, and such that adjacent pairs are positioned in back to back relation with portions of the backs of the elements of each pair being disposed in spaced apart relation to the back of the adjacent element of the next succeeding pair with said tie elements extending between said elements; bonding said pairs of face to face elements together to define a flow passage therebetween; and bonding a portion of the back of each of said elements of said pairs to the back of the adjacent element of the next succeeding pair to form an integral heat exchanger.

3. A method of manufacturing a heat exchanger from a continuous strip of thin metal stock comprising the steps of forming a plurality of pairs of elongated elements having a major dimension transverse with respect to said strip with tie elements having a width substantially less than the width of said strip extending therebetween; forming a complmentary face and a complementary back on each of said elements; folding said elements in a manner such that the elements of each pair are positioned in face to face relation, and such that adjacent pairs are positioned in back to back relation with portions of the backs of the elements of each pair being disposed in spaced apart relation to the back of the adjacent element of the next succeeding pair with said tie elements extending between said elements; placing fin material between said pairs; bonding said pairs of face to face elements together to define a flow passage therebetween; and bonding a portion of the back of each said elements of said pairs to the back of the adjacent element of the next succeeding pair and bonding said fin material to the spaced apart portion of the backs of adjacent pairs of elements to form an integral heat exchanger.

4. A method of manufacturing a heat exchanger from a continuous strip of thin metal stock comprising the steps of forming a plurality of pairs of elongated elements having a major dimension transverse with respect to said strip with tie elements having a width substantially less than the width of said strip extending therebetween; forming a complementary face and a complementary back on each of said elements; forming an aperture adjacent each end of each of said elements; folding said elements in a manner such that the elements of each pair are positioned in face to face relation, and such that adjacent pairs are positioned in back to back relation with the apertures of adjacent pairs disposed in substantial alignment, and with portions of the backs of the elements of each pair disposed in spaced apart relation to the back of the adjacent element of the next succeeding pair and with portions thereof in contact therewith, said contacting portions surrounding said apertures; bonding said pairs of face to face elements together to define a flow passage therebetween; and bonding the contacting portions of the backs of said elements of each pair to the contacting portions of the back of the adjacent element of the next succeeding pair to form an integral heat exchanger.

5. A method of manufacturing a heat exchanger from a continuous strip of thin metal stock comprising the steps of forming a plurality of pairs of elongated elements having a major dimension transverse with respect to said strip with tie elements having a width substantially less than the width of said strip extending therebetween; forming a complementary face, a complementary back, and complementary flanges on each of said elements; folding said elements in a manner such that the elements of each pair are positioned in face to face relation with said flanges engaging the complementary flange of the facing element, and such that adjacent pairs are positioned in back to back relation with portions of the backs of the elements of each pair being disposed in spaced apart relation to the back of the adjacent element of the next succeeding pair with said tie elements extending between said elements; bonding said pairs of face to face elements together to define a flow passage therebetween; and bonding a portion of the back of each of said elements of said pairs to the back of the adjacent element of the next succeeding pair to form an integral heat exchanger.

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