United States Patent

Keith

[15] **3,659,326**

[45] **May 2, 1972**

[54] PROCESS FOR PREPARING HEAT EXCHANGE COMPONENT

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[73] Assignee: **Olin Corporation**

[22] Filed: **Feb. 2, 1970**

[21] Appl. No.: **7,729**

Related U.S. Application Data

[60] Continuation-in-part of Ser. No. 708,463, Dec. 7, 1967, abandoned, and a continuation-in-part of Ser. No. 774,577, Nov. 1, 1968, Pat. No. 3,495,657, each is a division of Ser. No. 630,376, Apr. 12, 1967, abandoned.

[52] **U.S. Cl.** .....**29/157.3 V,** 113/118 D

[51] **Int. Cl.** **B21d 53/00,** B21k 29/00, B23p 15/26

[58] **Field of Search** .....29/157.3 V, 157.3 A, 157.3 D, 29/421 R; 165/170, 181; 113/118 R, 118 A, 118 B, 118 D

[56] **References Cited**

UNITED STATES PATENTS

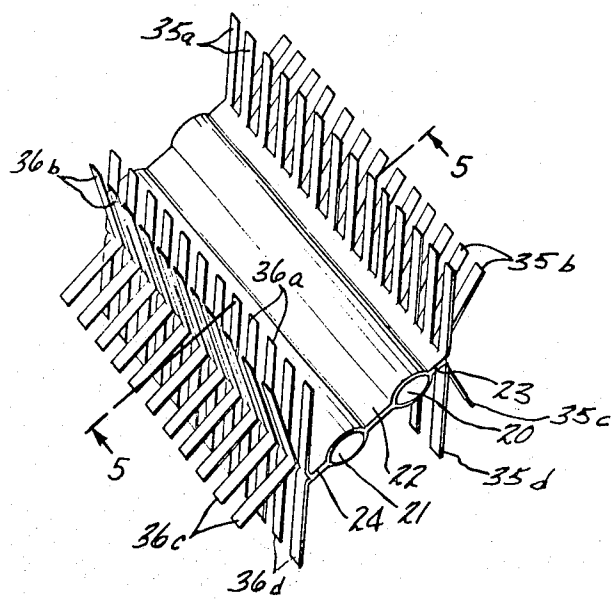
2,107,031	2/1938	Evans	165/170 X
2,646,972	7/1953	Schmid	165/170 X
2,896,312	7/1959	Schell	29/157.3 V
3,121,940	2/1964	Cospen	29/157.3 V
3,145,456	8/1964	Johnson	29/157.3 V
3,178,806	4/1965	Keith	29/157.3 V
3,205,563	9/1965	Pauls et al.	29/157.3 V
3,449,552	6/1969	Graves	29/157.3 A X
3,538,577	11/1970	O'Malley	113/118 D X

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[57] **ABSTRACT**

A process of producing continuous strip having at least one fluid passageway with integrally formed fin members, which comprises forming a pattern of weld inhibiting material on a first strip or sheet with a portion of the pattern defining the fluid passageway, and a further portion of the pattern extending along the edge of the strip or sheet defining a fin surface. A second strip or sheet of metal is pressure welded to the first strip or sheet in substantially all areas not containing the weld inhibiting material and the fin surface is formed into a plurality of fin members. The fin members may be formed by cutting, or by a combination of cutting, bending and twisting. Additional fin surface is obtained by separating the strip or sheet at their edge corresponding to the further portion of the pattern of weld inhibiting material. The strip or sheet, in accordance with the invention, may be formed into heat exchangers of any desired shape including a helix, spiral or serpentine.

28 Claims, 16 Drawing Figures



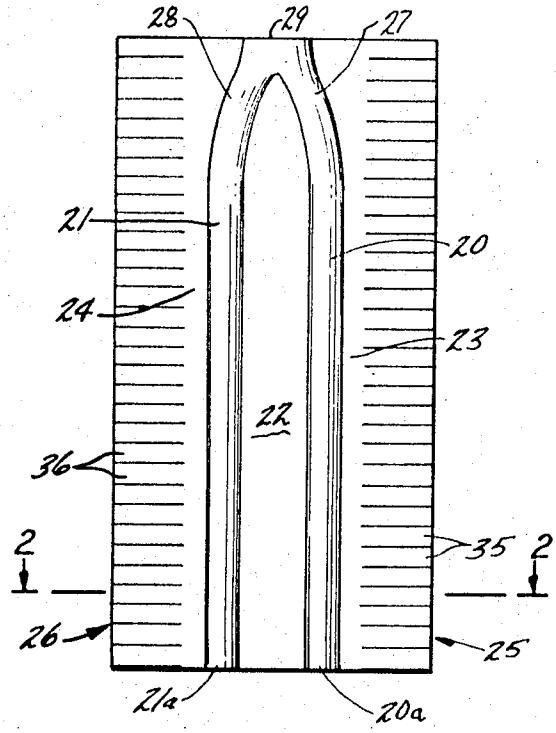


FIG - 3

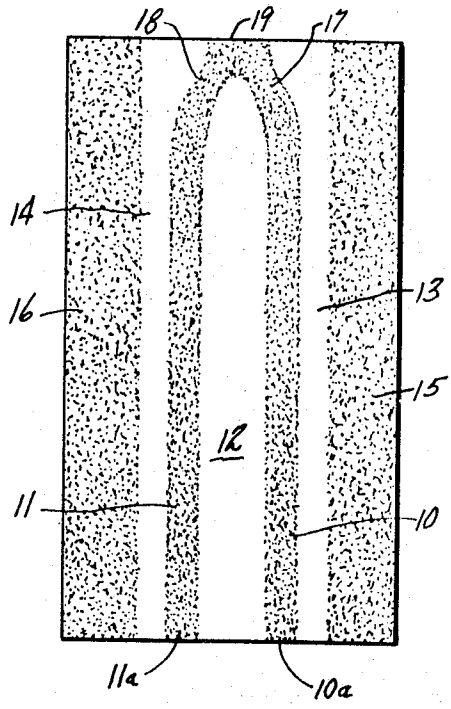


FIG - 1

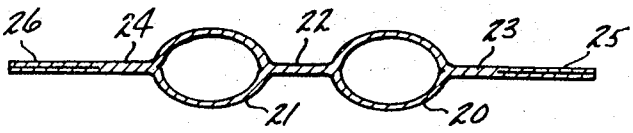


FIG - 2

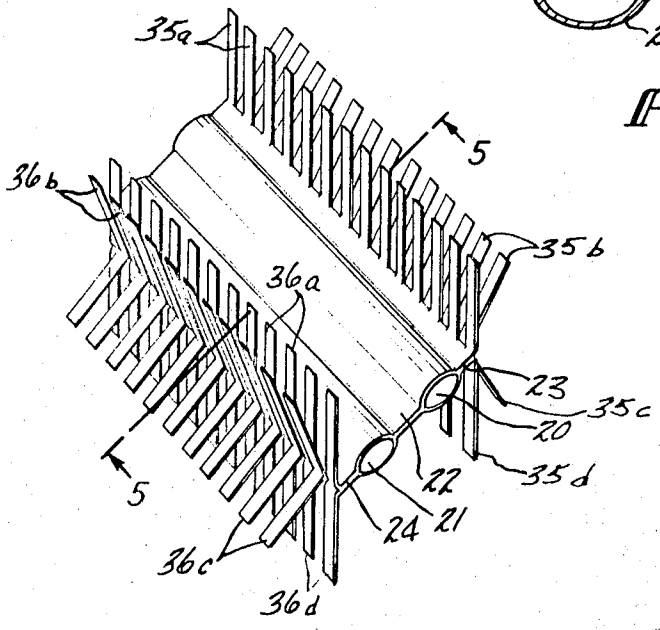


FIG - 4

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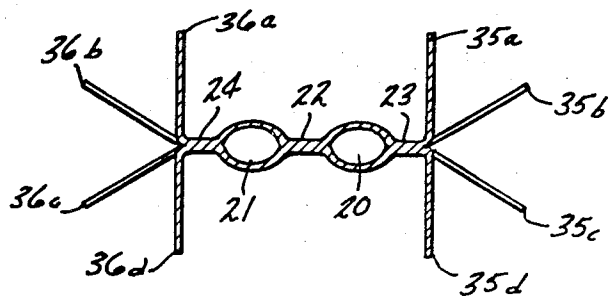


FIG-5

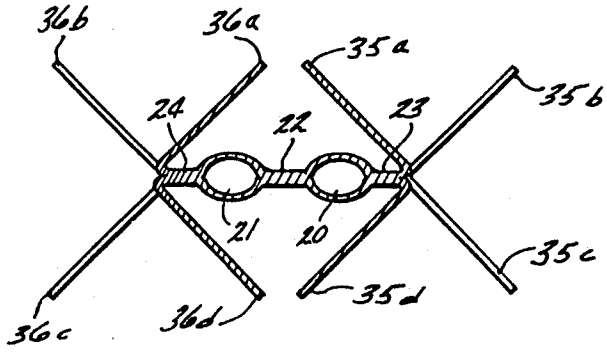


FIG-6

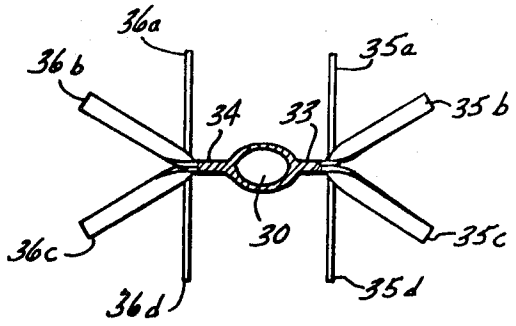


FIG-7

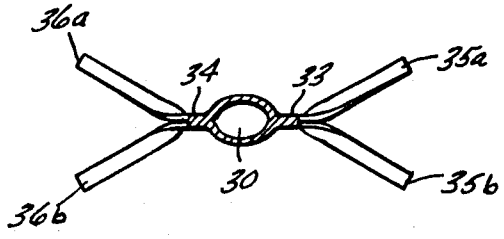


FIG-8

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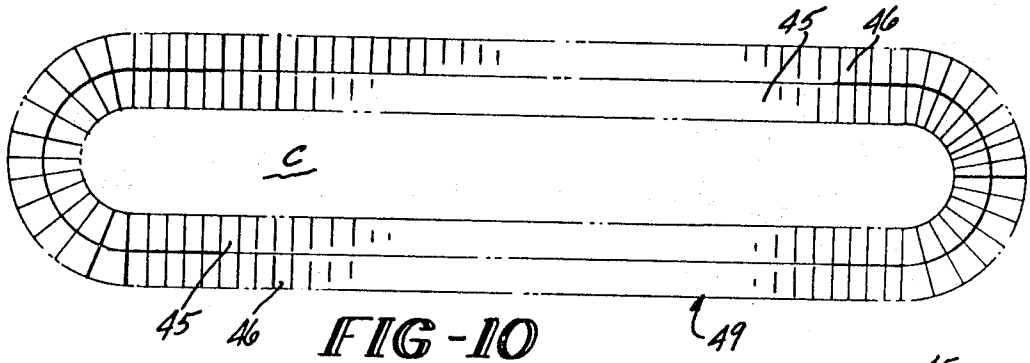


FIG-10

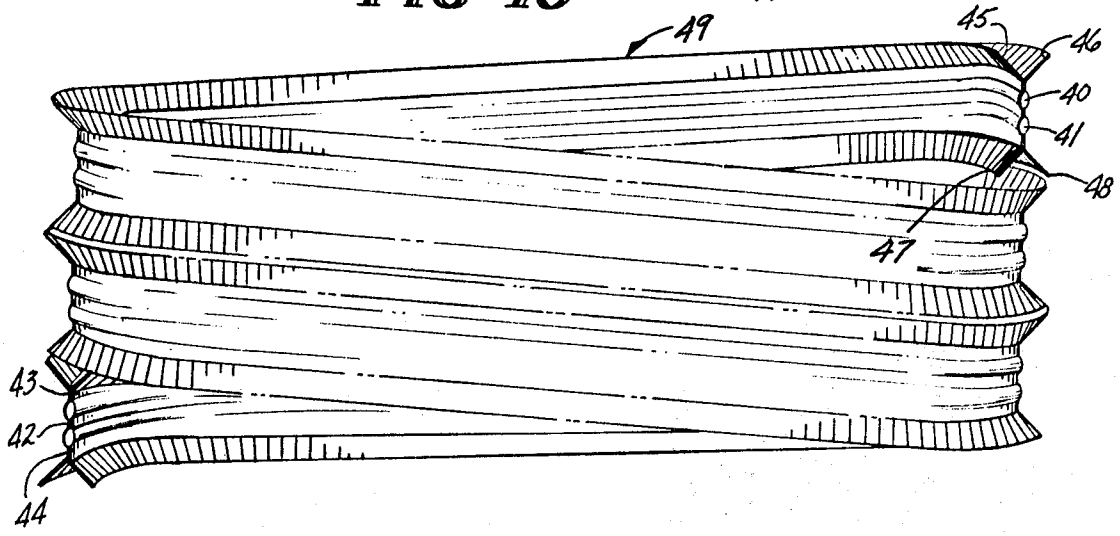


FIG-9

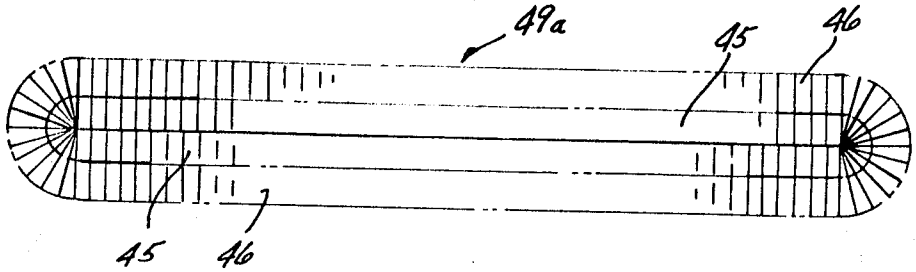


FIG-10A

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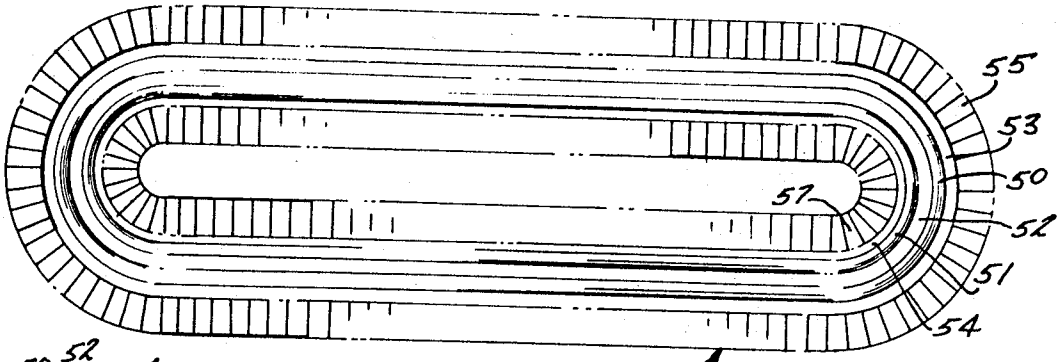


FIG-12

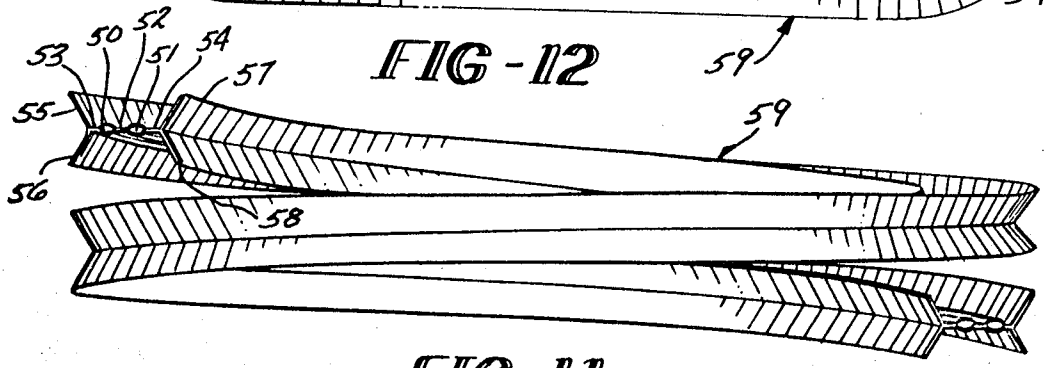


FIG-11

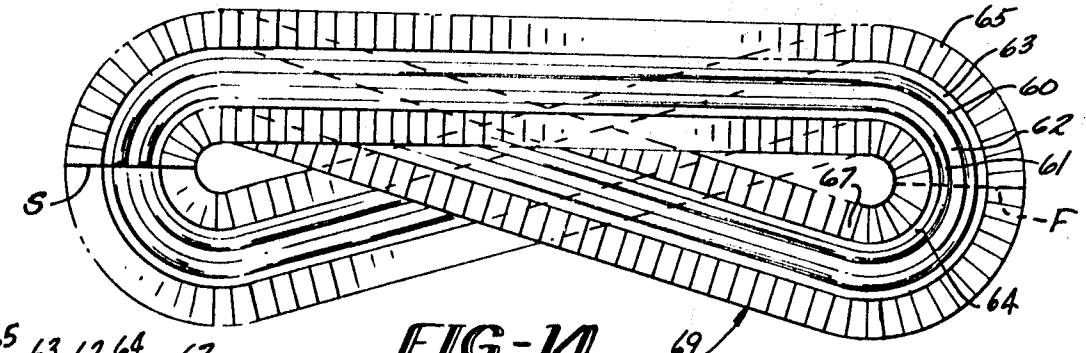


FIG-14

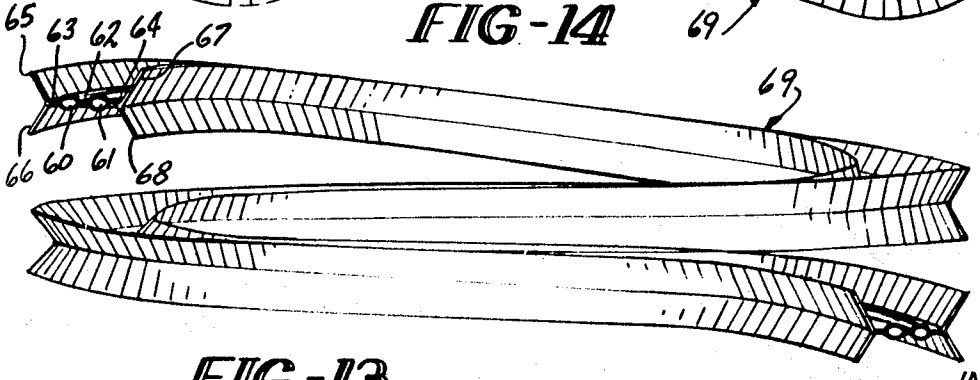


FIG-13

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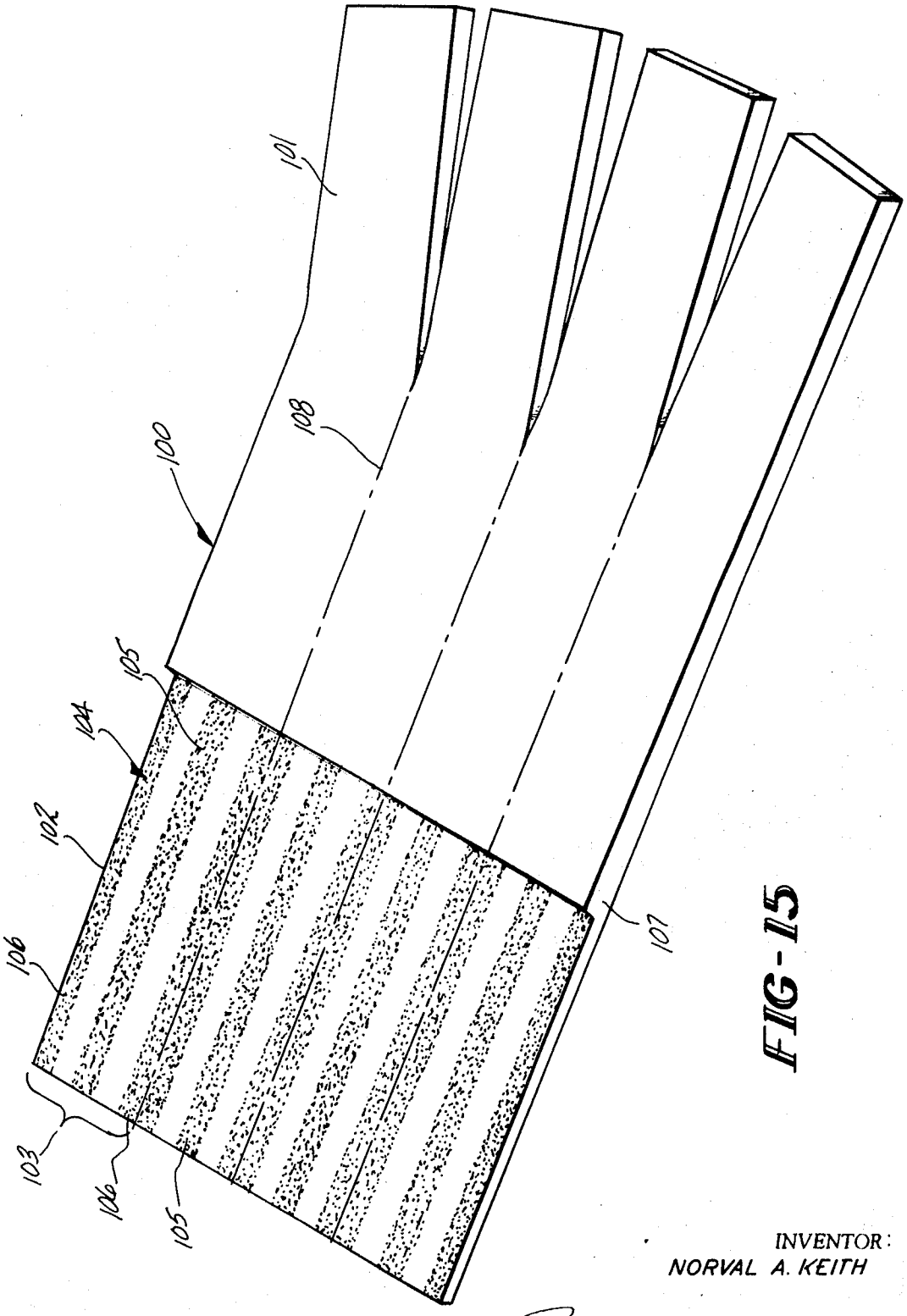


FIG-15

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PROCESS FOR PREPARING HEAT EXCHANGE COMPONENT

This application is a continuation-in-part of U.S. application Ser. No. 708,463, filed Dec. 7, 1967, now abandoned, and 774,577, filed Nov. 1, 1968, now U.S. Pat. No. 3,495,657, granted Feb. 17, 1970, which in turn are divisions of U.S. Ser. No. 630,376, filed Apr. 12, 1967, now abandoned.

This invention utilizes a process for bonding of at least two sheets of material in selective areas to provide a fluid passageway or a plurality of fluid passageways, and bending of the sheets in the edge areas to provide extended surfaces for heat exchange. The process may utilize wide sheets which are later cut into continuous strips or it may start with strip material.

For example, a continuous strip of metal may be patterned through a continuous patterning operation laying down a pattern of weld inhibiting material, and mated with at least one other strip. The strips are then either hot rolled or cold rolled to bond them together at places where there is no weld inhibiting material. Subsequent cold rolling may or may not be necessary if hot rolling has been used for the bonding. After rolling, and annealing if necessary, the strips may be separated along the edge of the continuous strip so as to provide a two or more layer finned surface. This finned surface can then be cut and bent if desired, and the bent portions may be twisted into the desired fin configuration. The so-bent strip can be formed into desired heat exchange shapes, for instance into a spiral, serpentine, etc.

FIG. 1 is a view of the pattern of the weld inhibiting material to be applied to a strip of metal according to one process of the invention.

FIG. 2 is a sectional view of the heat exchange component of the present invention at one stage of its fabrication.

FIG. 3 is a top view of the heat exchange component of the present invention at a different stage in its fabrication.

FIG. 4 is a schematic view of the heat exchange component according to the present invention.

FIG. 5 is a sectional view along the lines 5—5 in FIG. 4.

FIG. 6 is a sectional view of a modified heat exchange component according to the present invention.

FIG. 7 is a sectional view of a modified heat exchange component according to the present invention.

FIG. 8 is a sectional view of a modified heat exchange component according to the present invention.

FIG. 9 is a perspective view of a heat exchange component according to the present invention.

FIG. 10 is a top view of the component of FIG. 9.

FIG. 10A is a top view of a modification of the component of FIG. 9.

FIG. 11 is a perspective view of a heat exchange component according to another embodiment of the present invention.

FIG. 12 is a top view of the component of FIG. 11.

FIG. 13 is a perspective view of a heat exchange component according to another embodiment of the present invention.

FIG. 14 is a top view of the component of FIG. 13.

FIG. 15 is a perspective view showing the fabrication of a wide sheet in accordance with this invention.

The method of processing in accordance with this invention is based on the Grenell Pat. No. 2,690,002, granted Sept. 28, 1954, assigned to the assignee of the instant invention. Briefly, two or more sheets or strips of metal, which for example, may be aluminum, aluminum alloys, copper, copper alloys, steel, or other suitable metal, are first cleaned and brushed. Next, an appropriate pattern of weld inhibiting material is formed on a surface of at least one of the sheets or strips of metal. For a multi-sheet or strip article, weld inhibiting material might be applied to more than one of the sheets or strips, depending upon the pattern desired.

As shown in FIG. 1, using a two-strip article as an example, the weld inhibiting pattern may comprise two stripes 10 and 11. Stripes 12, 13 and 14 are provided which contain no weld inhibiting material. However, in the embodiment of the invention, external stripes 15 and 16 are provided with weld inhibiting material. If desired, the weld inhibiting stripes 10 and 11 may merge at 17 and 18 to provide an inlet portion 19. However, if desired, the stripes 10 and 11 may be so designed as to constitute a repeatable pattern and may form conduits of varying sizes. Also, if desired, the patterns 10 and 11 may merely extend to the edge of the strips as shown at 10*a* and 11*a*.

After application of the pattern, the strips are bonded together at places on their surfaces which do not contain weld inhibiting material. This can be done by either hot rolling or cold rolling.

Hot rolling and annealing temperatures will vary with the metals being processed. For example, aluminum sheets can be processed by heating the sheets to a temperature of between approximately 800° and 1,000° F, preferably approximately 900° and 950° F. After heating, the strips are hot worked to a reduction in gage of at least 60 percent. However, a greater amount of reduction will improve the bond and a reduction of approximately 65 percent is preferred.

The bonding can also be done by cold rolling, in which a reduction of for example, 70 percent is achieved in the first pass. A second cold reduction pass may or may not be used. However, if only one pass is used, the reduction may be even greater than 70 percent. The gage must be reduced by approximately 4 to 1.

As is known to one skilled in the art, of both hot and cold rolling, such process difficulties as control of camber must be controlled by known methods.

If hot rolling is used, following the hot reduction, the bonded strips are preferably cold rolled, for example, to a reduction of about 35 percent and then annealed. As an example, for aluminum and aluminum alloys sheets, a temperature of approximately 650° to 1,000° F is preferably used. If there has been no cold rolling, annealing is not necessary. Of course, if all cold reduction was used in the rolling, annealing at the indicated temperatures is necessary. The bonded composite may be slit to trim ragged edges prior to or subsequent to annealing and then sheared to the desired length after annealing. If desired, the bonded composite may be cut in the other direction to provide long thin strips. The sheared composite may then be inflated. For example, an inflation pressure of from approximately 500 to 3,000 p.s.i. may be used. Preferably, however, inflation is left for a later stage in the processing so the inflated tube will not be damaged during such processing. Normally, the inflation follows the formation of the fins.

If the inflation operation were performed at this point in the process, the resultant article would have a shape as shown in FIGS. 2 and 3. The patterns of weld inhibiting material 10, 11, 17, 18 and 19 would have resulted in corresponding tubular portions 20, 21, 27, 28 and 29. The sections 12, 13 and 14 would have resulted in bonded portions 22, 23 and 24, respectively. If weld inhibiting material was placed on sections 15 and 16 in FIG. 1, unbonded portions 25 and 26 will still contain the weld inhibiting material as shown in FIG. 2.

The articles shown in FIGS. 2 and 3 may or may not be cut. If cutting is done, it takes place in longitudinal edge portions 25 and 26, resulting in a plurality of slitted portions 35 and 36. The cutting operation can be done by means of conventional equipment.

If cutting has been done, the cut edge portions may then be bent to a desired fin configuration as shown in FIGS. 4 and 5. It will be apparent that the portions 35*a*, 35*b*, 35*c* and 35*d*, and 36*a*, 36*b*, 36*c* and 36*d* have been bent to a varying extent.

The extent to which the cut portions are bent is a matter of design. For example, as shown in FIG. 6, the portions 35*a* and 35*d* and 36*a* and 36*d* have been bent even further in this embodiment than was shown in FIG. 5.

In FIG. 7, cut edge portions 35*b* and 35*c* and 36*b* and 36*c* have not only been bent but have been rotated or twisted, approximately 90 percent, while the cut edge portions 35*a* and 35*d* and 36*a* and 36*d* have been bent but not rotated.

If weld inhibiting material was not placed upon either of the sections 15 and 16 in FIG. 2 according to another embodi-

ment of the invention, portions 25 and 26 may be cut as shown in FIG. 3 and then each cut portion may be bent and/or rotated a desired amount to form fin area.

For example, in FIG. 8, every other cut portion 35*a*, 36*a*, has been rotated upwardly, while every other cut portion 35*b*, 36*b* has been rotated downwardly.

Whether or not weld inhibiting material has been applied to the edge portions, the extent of the bending and rotating of the members will vary with the design and application and it will be apparent that many other designs of bending and rotating than those illustrated may be employed within the scope of the present invention.

The drawings in the present application show, as an example, a two-conduit unit in FIGS. 1 through 6. However, in many applications only one conduit will be used, as illustrated in FIGS. 7 and 8. The conduit 30 and welded portions 33 and 34 are obtained by using an appropriate weld inhibiting pattern and following a technique previously described in regard to a two-conduit pattern. It is apparent that any number of conduits may be provided within the scope of the present invention, by providing the appropriate weld inhibiting pattern upon the appropriate sheets.

Varying lengths of the heat exchange components shown in FIG. 4 may be produced. For many applications it is desirable to produce long lengths of such components. One such embodiment is shown in FIGS. 9 and 10. The article 49 has fin sections 45, 46, 47 and 48, conduit sections 40 and 41, and welded portions 42, 43 and 44. In FIG. 9, the fin sections 45, 46, 47 and 48 are shown as having been formed by cutting prior to being bent. However, it is to be understood that these fin sections could also be made by omitting the cutting and merely bending the cut sheets.

In FIG. 9, it is seen that the article has been bent into a spiral. This spiral unit can be used in forced air evaporators, such as those presently used in forced air refrigerators. If desired, as shown in FIG. 10A, the spiral may be wound more tightly to avoid the center C in FIG. 10, to form the article 49*a*.

In FIG. 9, it will be apparent that a transverse section appears where the numbers 40, 41 and 45–48 appear. In this transverse cross section, the major axis of the component passes through the bonded portions which are on either side of passageways 40 and 41. It will be apparent that the major axis in which the shape is bent and the major axis of the component in a transverse cross section are parallel in FIGS. 9, 10 and 10A.

FIGS. 11 and 12 show a structure similar to that shown in FIG. 9. The article 59 again has conduit portions 50 and 51 together with welded portions 52, 53 and 54. The fins 55, 56, 57 and 58 may be formed according to either of the methods described in regard to FIG. 9 (with or without cutting). The basic difference between the embodiments shown in FIGS. 11 and 12 and that shown in FIGS. 9 and 10 is that the axis of the component of which the spiral is formed is clearly different. The article 59 has the advantage that it can be used as either an air evaporator or a condenser heat exchanger with air flow across the convolutions.

FIGS. 13 and 14 show an article 69 again having conduit portions 60 and 61 together with welded portions 62, 63, 64 and fins 65, 66, 67 and 68. However, the article 69 is bent in a shape of a figure eight so as to provide more surface area in the center section of the unit.

FIG. 14 is a top view of FIG. 13 and includes a starting line S and a dotted finish line F in tracing the path of the figure eight shown in FIG. 14.

It will be apparent in the embodiment shown in FIGS. 11 and 12 and 13 and 14 that in a transverse cross section, the major axis of the component and the axis of the shape into which the article is bent are perpendicular.

It will be apparent to those skilled in the art that the heat exchange components of the present invention can be bent and/or wound into many other shapes to suit particular heat exchange applications.

It will also be apparent that the conduit portions must be appropriately connected to sources of the heat exchange medium to be passed therethrough by couplings known to those skilled in the art. For instance, soldered or brazed couplings may be used, or in some instances, rubber hose-type couplings can be used. The couplings are known in the art and do not form a part of the present invention except insofar as said couplings are associated with the heat exchange components of the present invention.

In accordance with another embodiment of the instant invention, the continuous strip can be produced from wide sheet metal 100 which is later slit into the strips 101 of the desired width. Referring to FIG. 15, there is shown a first sheet 102 which is wide enough to include a plurality of strip areas 103 with each strip area containing a suitable pattern of weld inhibiting material 104. The pattern 104 in each strip area 103 includes at least one portion 105 corresponding to an inflatable fluid passageway and may contain a plurality of portions 105. A further portion 106 of the pattern 104 in each strip area 103 is usually included which extends along the longitudinal edges of the resulting strip 101 so that the sheets 102, 107 of the strip 101 may be bent apart at the edges as set forth above. After the sheet 102 has been patterned, a second sheet 107 is pressure welded to it in the manner set forth above. The two sheets 102 and 107 become bonded together in all areas which do not include weld inhibiting material. The strip 101 is then formed by slitting or cutting the sheet along lines 108 corresponding to the boundary of each strip area 103. The resulting strips 101 may then be treated in accordance with the processing noted above, so as to form the desired heat exchange component. The wide sheet 100 of this embodiment may be made in very long lengths which may be coiled for ease in handling, and the strips 101 slit or cut from the sheet 100 may also be coiled prior to further processing.

If desired, a control tube pattern of weld inhibiting material in accordance with the process disclosed in copending U.S. application Ser. No. 5,548, filed Jan. 26, 1970, by N.A. Keith, assigned to the assignee of the instant application, may be included in a fixed relationship to the other patterns 104 in the sheet 100 so that the sheet may be slit employing the process and apparatus of the copending application. It is also to be understood that the pattern of weld inhibiting material may be formed by any desired technique including the process disclosed in application U.S. Ser. No. 723,055, filed Apr. 22, 1968, by N.A. Keith, assigned to the assignee of the instant invention.

It is to be understood that the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible of modifications of form, size, arrangement of parts and detail of operation. The invention rather is intended to encompass all such modifications which are within the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A process for producing finned strip having at least one inflatable fluid passageway with integrally formed fin members comprising:

providing at least one first strip of metal;

forming a first pattern of weld inhibiting material on said first strip, defining at least one inflatable fluid passageway;

forming a second pattern of weld inhibiting material upon at least a portion of at least one longitudinal edge of said first strip extending substantially along the length of said edge, said second pattern being spaced from said first pattern and defining a fin surface;

placing at least one second strip of metal upon said first strip;

bonding said sheets together at substantially all portions not containing weld inhibiting material; and

forming said fin surface into a plurality of fin members.

2. A process as in claim 1 which includes the step of: inflating said passageway to form an unobstructed tubular passageway completely defined by said first and second strips, and adapted to contain a heat exchange medium.

3. A process as in claim 2 wherein the forming of said fin surface into a plurality of fin members includes separating said strips of metal from each other at said second pattern at said at least one edge to form added fin surface in heat exchange relationship with said at least one inflatable fluid passageway.

4. A process as in claim 2 wherein the forming of said fin members includes the step of cutting said fin surface into a plurality of fin members.

5. A process as in claim 3 wherein the forming of said fin members includes the step of cutting said fin surface into a plurality of fin members.

6. A process as in claim 2 wherein the fin members are bent a desired amount.

7. A process as in claim 6 in which adjacent fin members are bent to differing extents.

8. A process as in claim 6 wherein the fin members are both bent and twisted.

9. A process as in claim 2 in which said strip has a plurality of passageways.

10. A process as in claim 2 wherein said strip is formed into a heat exchange component of desired shape.

11. A process as in claim 10 in which said shape is a helix.

12. A process as in claim 10 in which the shape is a spiral.

13. A process as in claim 10 in which the shape is a serpentine.

14. A process as in claim 2 wherein an identifying mark is placed upon one of the strips after the patterning operation, said mark being utilized to subdivide the bonded sheets.

15. A process for producing strip having at least one inflatable fluid passageway with integrally formed fin members comprising:

providing at least one sheet of metal, said sheet of metal containing a plurality of strip areas;

forming a first pattern of weld inhibiting material on said first sheet, defining at least one inflatable fluid passageway in each of said strip areas;

forming a second pattern of weld inhibiting material upon at least a portion of at least one longitudinal edge of each of said strip areas, said second pattern extending substantially along the length of said edge, said second pattern being spaced from said first pattern and defining a fin surface;

placing at least one second sheet of metal upon said first sheet;

bonding said sheets together at substantially all portions not containing weld inhibiting material;

forming said bonded sheets into a plurality of strips, with each strip corresponding to one of said strip areas; and

forming said fin surface into a plurality of individual fin members.

16. A process as in claim 15 which includes the step of inflating said at least one passageway in said strips to form an unobstructed tubular passageway adapted to contain a heat exchange medium.

17. A process as in claim 16 wherein the forming of said fin surface into a plurality of fin members includes separating said sheets of metal from each other in each of said strips at said second pattern in said at least one edge to form added fin surface in heat exchange relationship with said at least one inflatable fluid passageway.

18. A process as in claim 16 wherein the forming of said fin members includes the step of cutting said fin surface into a plurality of fin members.

19. A process as in claim 17 wherein the forming of said fin members includes the step of cutting said fin surface into a plurality of fin members.

20. A process as in claim 16 wherein the fin members are bent a desired amount.

21. A process as in claim 20 in which adjacent fin members are bent to differing extents.

22. A process as in claim 20 wherein the fin members are both bent and twisted.

23. A process as in claim 16 in which each of said strips has a plurality of passageways.

24. A process as in claim 16 wherein each of said strips is formed into a heat exchange component of desired shape.

25. A process as in claim 24 in which said shape is a helix.

26. A process as in claim 24 in which the shape is a spiral.

27. A process as in claim 24 in which the shape is a serpentine.

28. A process as in claim 16 wherein an identifying mark is placed upon one of the sheets after the patterning operation, said mark being utilized to subdivide the bonded sheets.

* * * * *