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Pasternak et al.

[11] **3,820,215**

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[54] **METHOD OF MAKING A CURVED SPINED HEAT EXCHANGER TUBE**

[75] Inventors: **Stephen F. Pasternak**, Park Ridge; **Stephen F. Pasternak, Jr.**, Chicago, both of Ill.

[73] Assignee: **Peerless of America, Incorporated**, Chicago, Ill.

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[52] **U.S. Cl.** ..... **29/157.3 A**, 29/157.3 B, 72/170

[51] **Int. Cl.** **B23p 15/26**, B21d 9/10

[58] **Field of Search** ..... 72/166, 170; 29/157.3 A, 29/157.3 B, DIG. 3; 113/118 A, 118 B

[56] **References Cited**

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Primary Examiner—Charles W. Lanham
Assistant Examiner—D. C. Reiley, III
Attorney, Agent, or Firm—Root & O'Keeffe

[57] **ABSTRACT**

The method of making a curved, spined heat transfer element by applying bending forces only to portions disposed outwardly of the spines.

4 Claims, 3 Drawing Figures

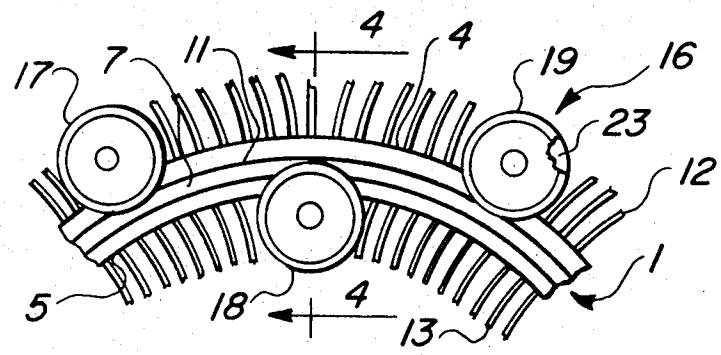


Fig - 1

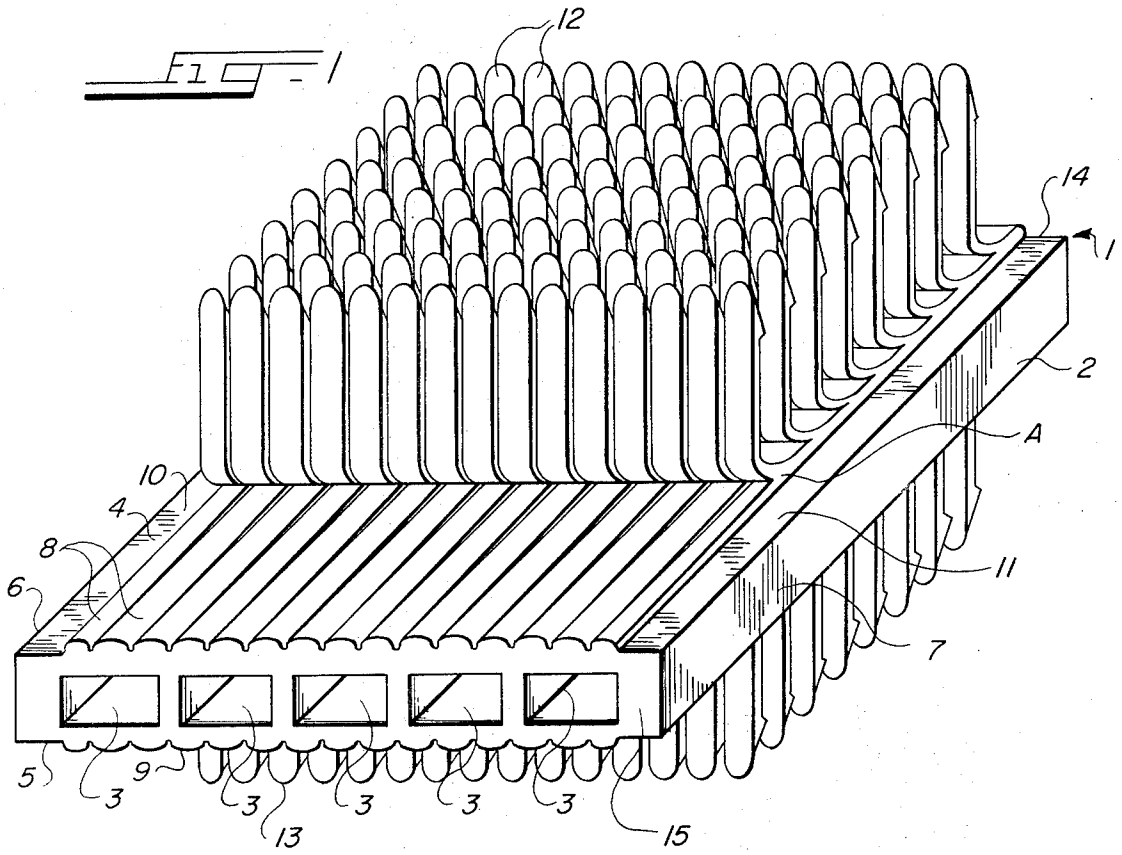


Fig - 3

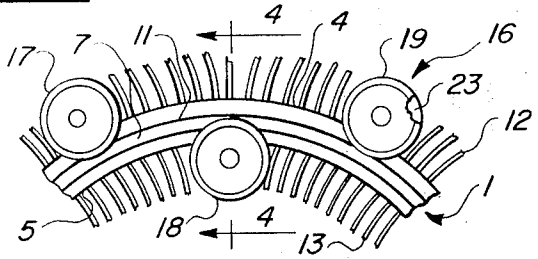


Fig - 4

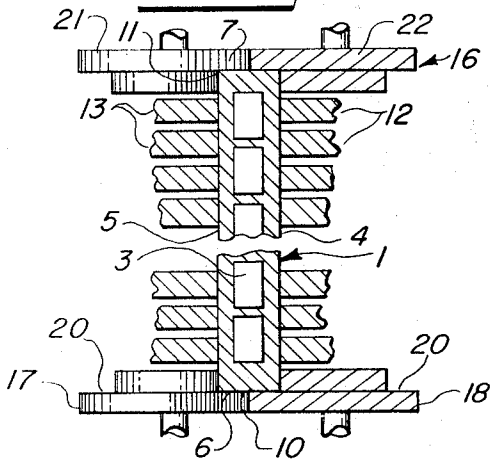
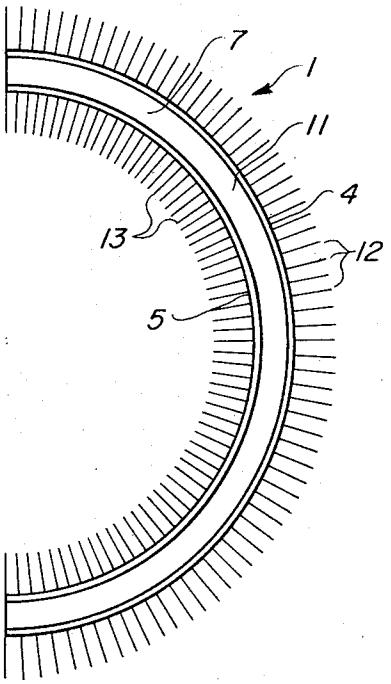


Fig - 2



METHOD OF MAKING A CURVED SPINED HEAT EXCHANGER TUBE

BACKGROUND OF THE INVENTION

This invention relates to heat exchangers and, more particularly, to the method of making heat exchangers.

It is a primary object of the present invention to afford a novel method of making a curved heat transfer element.

It is another object of the present invention to afford a novel method of making a curved spined heat transfer element.

Spined, tubular heat transfer elements have long been known in the art, being shown, for example, in R. W. Kritzer U.S. Pat. Nos. 3,202,212 and 3,229,722 and in Joseph M. O'Connor U.S. Pat. No. 3,692,105. They have had extensive use commercially. The spines on such commercial heat transfer elements 10 are thin, commonly having a thickness in the nature of 10,000 -thousands to 30-thousands of an inch.

Also, curved heat transfer elements having spines of the aforementioned type disposed on the inside or the outside of the curve, or both, have been heretofore known in the art. Insofar as we have knowledge, the formation of such curved, spined heat transfer elements heretofore has always been accomplished by methods which required the application of bending forces directly on the spines thereof. Even when carefully accomplished, and with the bending forces spread over relatively large areas of spines, such bending or curving by the application of force to the spines, has always caused undesirable deformation of the spines. It is an important object of the present invention to overcome such deformation.

Another object of the present invention is to completely eliminate such deformation.

Yet another object of the present invention is to enable curved, spined heat exchangers to be formed in a novel and expeditious manner without the application of any bending forces to the spines.

A further object of the present invention is to enable an elongated heat exchanger to be longitudinally curved in a novel and expeditious manner by all of the bending forces, necessary for such curving, being applied only at the longitudinal edge portions of the heat exchanger.

An object ancillary to the foregoing is to afford a novel method of longitudinally curving an elongated heat exchanger by the application of bending forces to longitudinal edge portions, which edge portions comprise a minor part of the entire width of the heat exchanger.

Another object of the present invention is to afford a novel method of making curved, spined heat exchangers, which is practical and efficient, and which may be carried out commercially in an expeditious and economical manner.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show the preferred embodiment of the present invention and the principles thereof and what we now consider to be the best mode in which we have contemplated applying these principles. Other embodiments of the invention embodying

the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view of a length of heat exchanger element or heat transfer element, embodying the principles of the present invention, and showing the same at an intermediate step in the formation thereof;

FIG. 2 is a side elevational view, somewhat diagrammatic in character, showing a spined heat exchanger element of the type shown in FIG. 1 disposed in longitudinally curved form;

FIG. 3 is a fragmentary, somewhat diagrammatic elevational view of the heat exchanger elements shown in FIGS. 1 and 2, showing the heat exchanger element passing through a bender during the curving thereof; and

FIG. 4 is a fragmentary, detail sectional view taken substantially along the line 4—4 in FIG. 3;

DESCRIPTION OF THE EMBODIMENT SHOWN HEREIN

To illustrate the presently preferred method of making heat exchangers in accordance with the principles of the present invention, a heat exchanger element or heat transfer element 1 is shown in FIGS. 1–4 at various stages of the formation thereof.

The heat exchanger 1, shown in FIG. 1, embodies a length of tubular stock, in the form of a tubular member 2, which is substantially rectangular in transverse cross-section, and has a plurality of passageways 3 extending through the member 2 in parallel spaced relation to each other. As shown in FIG. 1, the tubular member 2 embodies an upper face 4, a lower face 5 and oppositely disposed side edges, or side faces 6 and 7, respectively.

The tubular member 2 may be made of any suitable material such as, for example, aluminum, and may be made in any suitable manner such as, for example, by extruding the same. Preferably, the tubular member 2 embodies a plurality of elongated ribs 8 projecting outwardly from the face 4 and extending longitudinally the entire length of the tubular member 2 in substantially parallel spaced relation to each other; and also embodies elongated ribs 9 similarly disposed on the face 5. The outermost ribs of each plurality of ribs 8 and 9 disposed on the faces 4 and 5, respectively, are disposed inwardly from the respective side edges 6 and 7 of the tubular member 2 to afford longitudinal edge portions 10 and 11, respectively, which extend the full length of the tubular member 2 in laterally outwardly projecting relation to the ribs 8 and 9. In tubular members constructed in accordance with the present invention, each of the edge portions 10 and 11 is a minor portion of the overall transverse width of the tubular member, and preferably is in the nature of between four percent and nine percent thereof.

In the heat exchanger 1, shown in FIGS. 1 and 2, a plurality of spaced spines or elongated fins 12 and 13 project outwardly from the faces 4 and 5, respectively, of tubular member 2. The spines 12 and 13 are confined to the areas of the ribs 8 and 9, respectively, and preferably are formed from the ribs 8 and 9 in such a

manner that a plurality of the spines **12** and **13** project outwardly from each of the ribs **8** and **9**, respectively, in closely spaced relation to each other, and, in the finished heat exchanger **1**, substantially throughout the length thereof.

The spines **12** and **13** may be formed in any suitable manner such as, for example, in the manner disclosed in greater detail in the Kritzer U.S. Pat. Nos. 3,202,212 and 3,229,722, whereby they are successively sliced or gouged from the respective ribs **8** and **9** from one end of the tubular member **2**, such as the end **14**, shown in FIG. **1**, toward the other end thereof, such as the end **15** shown in FIG. **1**. As discussed in the aforementioned Kritzer U.S. Pat. No. 3,202,212, as the fins **12** and **13** are formed from the ribs **8** and **9**, respectively, they may be turned outwardly into outwardly projecting relation to the faces **4** and **5**, respectively.

After the formation of the spines **12** and **13**, a suitable length of the tubular member **2**, such as the length extending from the end **14** thereof to the point A shown on FIG. **1**, may be cut off to thereby afford a heat exchanger having the tubular construction of the tubular member **2**, and having spines **12** and **13** projecting outwardly from opposite faces thereof. In the thus formed heat exchanger, the lateral edges of the outermost spines on each of the faces **4** and **5** are disposed in inwardly spaced relation to the longitudinal edges **6** and **7** of the heat exchanger, thus affording the outwardly projecting longitudinal edge portions **10** and **11**, which project outwardly from the plurality of spines **12** and **13** throughout the length of the heat exchanger **1**. At this stage in the formation of the curved heat exchanger **1**, shown in FIG. **2**, the heat exchanger **1** is substantially flat, throughout its length as shown in FIG. **1**.

In order to produce the longitudinally curved heat exchanger **1**, shown in FIG. **2**, it is necessary to apply bending forces to the aforementioned substantially flat heat exchanger **1** by suitable bending tools or bending apparatus. In accordance with the principles of the present invention, such forces are only applied to the longitudinal edge portions **10** and **11** of the heat exchanger **1**. For this purpose, we prefer that the aforementioned bending forces be applied by, what is known in the trade as, a three-roll bender, such as the bender **16** shown, somewhat diagrammatically in FIGS. **3** and **4**.

The bender **16** embodies three rollers **17**, **18** and **19**, FIG. **3**, disposed in radial alignment with each other. The rollers **17** and **19** are disposed in position to engage one of the longitudinal edge portions **10** or **11** of the heat exchanger **1** along the arc to which it is desired to bend the radially outermost portion of the thus engaged longitudinal edge portion **10** or **11**, during passage of the heat transfer element **1** through the bender **16**. The roller **18** is disposed in position to engage the radially innermost face of the aforementioned longitudinal edge portion **10** or **11**, which passes through the bender **16** in engagement with the rollers **17** and **19**, on the aforementioned desired arc. Each of the rollers **17–19** has a notch or groove **20**, FIG. **4**, extending around the periphery thereof, for the reception of the outer edge portion of the longitudinal edge portion **10** or **11**, of the heat transfer element **1**, with which it is engaged during passage of the heat transfer element **1** through the bender **16**.

The bender **16** also includes three additional rollers **21**, **22** and **23**, disposed in spaced, axial alignment with the rollers **17**, **18** and **19**, respectively. The rollers **21–23** are identical to the rollers **17–19** and are disposed in the same relation to each other as the rollers **17–19**, respectively, along the path of travel of the heat exchanger **1** through the bender **16**, except that they are disposed in position to operatively enage the other longitudinal edge portion **11** or **10** of the heat exchanger **1**.

In the practice of this method of bending a heat exchanger into a curved form, as shown in FIG. **2**, the bending forces are applied only along the outer longitudinal edge portions of the heat exchanger. This, it will be seen, enables spined heat exchangers, such as those shown in FIGS. **1** and **2**, to be bent into curved form without any bending forces being applied to the spines, themselves, which heretofore, was common practice in the art. As previously mentioned, the aforementioned longitudinal edge portion, with which the bender is engaged at each side of the heat exchanger **1**, constitutes a minor portion of the transverse width of the heat exchanger, and, preferably, is between four percent and nine percent thereof.

From the foregoing it will be seen that the present invention affords a novel method of making longitudinally curved heat exchangers.

Also, it will be seen that the present invention affords a novel method of making longitudinally curved heat exchangers, which is particularly well adapted for use in the manufacture of spined heat exchangers.

Also, it will be seen that the present invention affords a novel method of making a curved spined heat exchanger which is commercially practical.

Thus, while we have illustrated and described the preferred embodiment of our invention, it is to be understood that this is capable of variation and modification, and we therefore do not wish to be limited to the precise details set forth, but desire to avail ourselves of such changes and alterations as fall within the purview of the following claims.

We claim:

1. The method of making a heat transfer element comprising

a. forming an elongated tubular member having a greater traverse width than height and having a wall portion with

1. an intermediate portion extending transversely across the major portion of the width of said tubular member, said intermediate portion being substantially covered with a plurality of outwardly projecting members, and

2. two longitudinal edge portions disposed on respective opposite sides of said intermediate portion, and

b. forming said tubular member into a longitudinally extending curve by applying bending forces to said outer longitudinal edge portions only.

2. The method of making a heat transfer element comprising

a. forming an elongated tubular member having a greater traverse width than height and having a wall portion with

1. a plurality of outwardly projecting spines spaced from each other longitudinally of said wall portion and substantially covering the major portion of the width of said tubular member, and

2. two outer longitudinal edge portions disposed on respective opposite sides of said major portion and projecting outwardly therefrom, and

b. applying bending forces directly to said outer longitudinal edge portions only to thereby form said tubular member into a curve.

3. The method of making a heat transfer element comprising

a. forming an elongated tubular member having a greater traverse width than height and having a wall portion with

1. laterally spaced elongated ribs extending longitudinally thereof, each of said ribs being spaced traversely across the major portion of the width of said tubular member, and

2. oppositely disposed outer longitudinal edge portions disposed on respective sides of said ribs and projecting laterally outwardly therefrom,

b. forming elongated, spaced, outwardly projecting fins along each of said ribs, and

c. bending said tubular member into a curve by applying bending forces to only said longitudinal edge portions transversely to the lateral spacing of said ribs.

4. The method of making a heat transfer element comprising

a. forming an elongated tubular member having a greater traverse width than height and having two oppositely disposed wall portions, with

1. laterally spaced, outwardly projecting, elongated ribs extending longitudinally of each of said wall portions,

2. outwardly projecting spines spaced along respectives ones of said ribs, and

3. two longitudinal edge portions extending between said wall portions and projecting laterally outwardly from said spines on opposite sides thereof, and

b. bending said tubular member into a curve, with said spines on one of said wall portions disposed on the inside of said curve and said spines on the other of said wall portions disposed on the outside of said curve, by applying

1. two spaced forces to only said longitudinal edge portions on the outside of said curve, and

2. another force, between said two forces, to only said longitudinal edge portions on the inside of said curve.

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