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# (54) HEAT EXCHANGER TUBE AND METHOD OF MAKING

WÄRMETAUSCHERROHR UND HERSTELLUNGSVERFAHREN DAFÜR

TUBE POUR ÉCHANGEUR DE CHALEUR ET SON PROCÉDÉ DE FABRICATION

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## Description

**[0001]** The present invention relates to a method of forming a tube for a heat exchanger according to the features of the preamble of claim 1.

**[0002]** Such a method is for example disclosed in US-A-4720902. The subject matter disclosed herein relates to heat exchangers. More specifically, the subject disclosure relates to tubular coils for heat exchangers.

**[0003]** A heat exchanger typically includes two or more containment forms, such as tubes, through which a cooling fluid is circulated. The heat exchanger also includes a plurality of fins extending between the tubes which facilitate thermal energy transfer between the tubes and the surrounding air. In assembling the heat exchanger, each tube is expanded to provide an interference fit between the tube and adjacent fins. Further, ends of adjacent tubes are connected to each other via a return bend section of tubing forming a labyrinthian coil. To accommodate connection to the return bend, the end of the tube is belled (or increased in diameter) allowing the return bend to be received in the end of the tube. Further, the end of the tube is flared to capture braze material when brazing the tube to the return bend. To accomplish the expansion, bell and flare, a tool is inserted into the tube which includes a form for the expansion, or bullet, at a first end and dies to produce the bell and flare shapes at a second end. As the tool is forced down the length of the tube, the expanded shape is produced along the length, and finally the bell and flare are produced at the end of the tube. Typically this is done in a single-step process in which the tube is expanded belled and flared via a single stroke of tool along the length. This expansion method presents a problem for tubes with relatively low buckling limits, for example, tubes formed from aluminum. Aluminum tubes are typically thicker-walled than steel or cooper tubes, thus a higher force is required for the expansion process. When expansion, flare and belling forces act on a single tube simultaneously, the forces may exceed the buckling limit resulting in failure of the tube. Thus, the tube must be scrapped and replaced with another tube.

**[0004]** US 4876779 discloses a method of manufacture of a tube for a heat exchanger using an expanding/belling station with separate beller tools and expander tools.

**[0005]** According to the invention, a method of forming a tube for a heat exchanger includes advancing an expansion tool into a tube a first time and engaging a bullet of the expansion tool with the tube to expand the tube diametrically at least partially along a length of the tube to form an interference fit of the tube with fins of the heat exchanger. The expansion tool is at least partially retracted from the tube. The expansion tool is advanced into the tube one or more subsequent times and once the expansion of the tube by the bullet is complete, a stroke of the expansion tool is continued, thereby engaging a bell tool portion of the expansion tool with a tube end of the tube to further expand the tube end in order for the tube end to receive a return bend.

**[0006]** According to a preferred aspect of the invention, a method of assembling a heat exchanger includes providing a plurality of fins and locating one or more tubes in proximity to the plurality of fins. The tubes are formed using a method as described above.

**[0007]** These and other advantages and features will become more apparent from the following description of example embodiments taken in conjunction with the drawings.

**[0008]** The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is schematic view of an embodiment of a heat exchanger;

FIG. 2 is a cross-sectional view of an embodiment of a heat exchanger tube;

FIG. 3 is another cross-sectional view of an embodiment of a heat exchanger tube; and

FIG. 4 is yet another cross-sectional view of an embodiment of a heat exchanger tube.

**[0009]** The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

**[0010]** Shown in FIG. 1 is an embodiment of a heat exchanger 10. The heat exchanger 10 includes a plurality of heat exchanger tubes 12, which fit to a plurality of fins 14 to transfer thermal energy between a flow 16 passing through the fins 14 and the tubes. Each tube 12 has a tube end 18, which is joined to a return bend 20 to form a labyrinth coil 22.

**[0011]** Referring now FIG. 2, an expansion tool 22 is driven into the tube 12 to expand the tube 12 diametrically along a tube length 24 to force an interference fit with the fins 14 thereby better facilitating thermal energy transfer. Further, the expansion tool 22 is utilized to bell and flare the tube end 18 to receive the return bend 20. Illustrated in FIGs. 2-3 is an improved method for expanding, belling and flaring the tube end 18 for the heat exchanger 10. Referring to FIG. 2, in an initial stroke of the expansion tool 22 into the tube 12, the tube 12 is expanded to an interference fit with the fins 14 by a bullet 26. Once the expansion of the tube 12 is complete, the expansion tool 22 retracts along the tube 12. It is to be appreciated that while in the embodiment of FIG. 2, expansion of the tube 12 is achieved in a single stroke of the expansion tool 22, it is to be appreciated that additional, multiple strokes of the expansion may be utilized to achieve the desired

expansion. For example, a first stroke of the expansion tool 22 may extend to about one half of the tube length 24, resulting in expansion of about one half of the tube 12. An additional stroke is then utilized to expand the remaining portion of the tube length 24.

**[0012]** Referring now to FIG. 3, another stroke of the expansion tool 22 is initiated and the stroke continues until a bell tool 28 portion of the expansion tool 22 engages the tube end 18 to further expand the tube end 18 to receive the return bend 20.

**[0013]** In some embodiments, subsequent to the bell tool portion 28 engaging the tube end 18, a flare tool portion 30 engages the tube end 18 to flare the tube end 18 outwardly. Once the bell and flare operations are completed, the expansion tool 22 is withdrawn, and as shown in FIG. 4, the return bend 20 is assembled to the tube end 18 and secured thereto by, for example, brazing. In the embodiment described above, the bell and flare operations are performed with separate strokes of the expansion tool 22, but it is to be appreciated that, in some embodiments, the bell and flare operations may be combined into a single stroke of the expansion tool 22 if a force necessary to perform the operations does not exceed the buckling limit of the tube 12. Utilizing multiple strokes of the expansion tool 22 into the tube 12 to fully expand the tube 12 to a final configuration reduces the forces acting on the tube 12 due to the expansion when compared to those acting on the tube 12 in a single-stroke expansion process. Therefore, the risk of exceeding the buckling limit of the tube 12 is reduced, resulting in fewer tubes 12 which are damaged during the expansion process.

**[0014]** While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the scope of the invention as defined by the claims. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

## Claims

1. A method of forming a tube for a heat exchanger (10) comprising:

   advancing an expansion tool (22) into a tube (12) a first time;
   engaging a bullet (26) of the expansion tool (22) with the tube (12) to expand the tube (12) diametrically at least partially along a length (24) of the tube (12) to form an interference fit of the tube (12) with fins (14) of the heat exchanger; and
   at least partially retracting the expansion tool (22) from the tube (12);
   **characterised by**:

   advancing the expansion tool (22) into the tube (12) one or more subsequent times; and
   once the expansion of the tube by the bullet (26) is complete, continuing a stroke of the expansion tool (22) and engaging a bell tool portion (28) of the expansion tool (22) with a tube end (18) of the tube (12) to further expand the tube end in order for the tube end to receive a return bend.

2. The method of Claim 1, wherein advancing the expansion tool (22) into the tube (12) the first time comprises advancing the expansion tool (22) along the entire length of the tube, thereby diametrically expanding the entire length of the tube.

3. The method of Claim 1, wherein engaging the expansion tool (22) with the tube (12) one or more subsequent times results in expansion of a tube end (18) to receive a return bend (20).

4. The method of Claim 1, wherein engaging the expansion tool (22) with the tube (12) one or more subsequent times results in a flare of a tube end (18).

5. The method of Claim 1, wherein one or more subsequent times is one more time.

6. The method of Claim 1, wherein one or more subsequent times is two more times.

7. A method of assembling a heat exchanger (10) comprising:

   providing a plurality of fins (14);
   locating one or more tubes (12) in proximity to the plurality of fins; and
   forming the one or more tubes using a method as claimed in any preceding claim.

## Patentansprüche

1. Verfahren zum Formen eines Rohrs für einen Wärmetauscher (10), umfassend:

   das erstmalige Vorwärtsbewegen eines Erweiterungswerkzeugs (22) in ein Rohr;
   das Eingreifen eines Rohrmolchs (26) des Erweiterungswerkzeugs (22) in das Rohr (12), um

das Rohr (12) mindestens teilweise entlang einer Länge (24) des Rohrs (12) diametrisch zu erweitern, um eine Presspassung des Rohrs (12) mit Rippen (14) des Wärmetauschers zu bilden; und
das mindestens teilweise Zurückziehen des Erweiterungswerkzeugs (22) aus dem Rohr (12); **gekennzeichnet durch**:

das Vorwärtsbewegen des Erweiterungswerkzeugs (22) in das Rohr (12) ein oder mehrere weitere Male; und
wenn die Erweiterung des Rohrs durch den Rohrmolch (26) fertiggestellt ist, das Fortsetzen eines Hubs des Erweiterungswerkzeugs (22) und Eingreifen eines Glockenwerkzeugabschnitts (28) des Erweiterungswerkzeugs (22) in ein Rohrende (18) des Rohrs (12), um das Rohrende weiter zu erweitern, sodass das Rohrende einen Umkehrbogen aufnehmen kann.

**2.** Verfahren nach Anspruch 1, wobei das erstmalige Vorwärtsbewegen des Erweiterungswerkzeugs (22) in das Rohr (12) das Vorwärtsbewegen des Erweiterungswerkzeugs (22) entlang der gesamten Länge des Rohrs umfasst, wodurch die gesamte Länge des Rohrs diametrisch erweitert wird.

**3.** Verfahren nach Anspruch 1, wobei das Eingreifen des Erweiterungswerkzeugs (22) in das Rohr (12) ein oder mehrere weitere Male zu einer Erweiterung eines Rohrendes (18) führt, um einen Umkehrbogen (20) aufzunehmen.

**4.** Verfahren nach Anspruch 1, wobei das Eingreifen des Erweiterungswerkzeugs (22) in das Rohr (12) ein oder mehrere weitere Male zu einer fächerförmigen Öffnung eines Rohrendes (18) führt.

**5.** Verfahren nach Anspruch 1, wobei ein oder mehrere weitere Male ein weiteres Mal bedeutet.

**6.** Verfahren nach Anspruch 1, wobei ein oder mehrere weitere Male zwei weitere Male bedeutet.

**7.** Verfahren eines Zusammenbaus eines Wärmetauschers (10), umfassend:

Bereitstellen einer Vielzahl von Rippen (14);
Platzieren eines oder mehrerer Rohre (12) in der Nähe der Vielzahl von Rippen; und
Formen des einen oder der mehreren Rohre unter Verwendung eines Verfahrens nach einem der vorstehenden Ansprüche.

**Revendications**

**1.** Procédé de formation d'un tube pour un échangeur de chaleur (10) comprenant :

un avancement d'un outil d'expansion (22) dans un tube (12) une première fois ;
un engagement d'une balle (26) de l'outil d'expansion (22) avec le tube (12) pour élargir le tube (12) diamétralement au moins partiellement le long d'une longueur (24) du tube (12) pour former un ajustement avec serrage du tube (12) avec des ailettes (14) de l'échangeur de chaleur ; et
une rétractation de l'outil d'expansion (22) au moins partiellement du tube (12) ;
**caractérisé par** :

un avancement de l'outil d'expansion (22) dans le tube (12) une ou plusieurs fois consécutives ; et
une fois que l'expansion du tube par la balle (26) est terminée, une poursuite d'une course de l'outil d'expansion (22) et un engagement d'une partie d'outil en cloche (28) de l'outil d'expansion (22) avec une extrémité de tube (18) du tube (12) pour élargir davantage l'extrémité de tube afin que l'extrémité de tube reçoive un coude en U.

**2.** Procédé selon la revendication 1, dans lequel l'avancement de l'outil d'expansion (22) dans le tube (12) la première fois comprend un avancement de l'outil d'expansion (22) sur toute la longueur du tube, élargissant ainsi diamétralement toute la longueur du tube.

**3.** Procédé selon la revendication 1, dans lequel un engagement de l'outil d'expansion (22) avec le tube (12) une ou plusieurs fois consécutives entraîne l'expansion d'une extrémité de tube (18) pour recevoir un coude en U (20).

**4.** Procédé selon la revendication 1, dans lequel un engagement de l'outil d'expansion (22) avec le tube (12) une ou plusieurs fois consécutives entraîne un évasement d'une extrémité de tube (18).

**5.** Procédé selon la revendication 1, dans lequel une ou plusieurs fois consécutives est une fois de plus.

**6.** Procédé selon la revendication 1, dans lequel une ou plusieurs fois consécutives est deux fois de plus.

**7.** Procédé d'assemblage d'un échangeur de chaleur (10) comprenant :

une fourniture d'une pluralité d'ailettes (14) ;

un positionnement d'un ou plusieurs tubes (12) à proximité de la pluralité d'ailettes ; et
une formation de l'un ou plusieurs tubes en utilisant un procédé tel que revendiqué dans une quelconque revendication précédente.

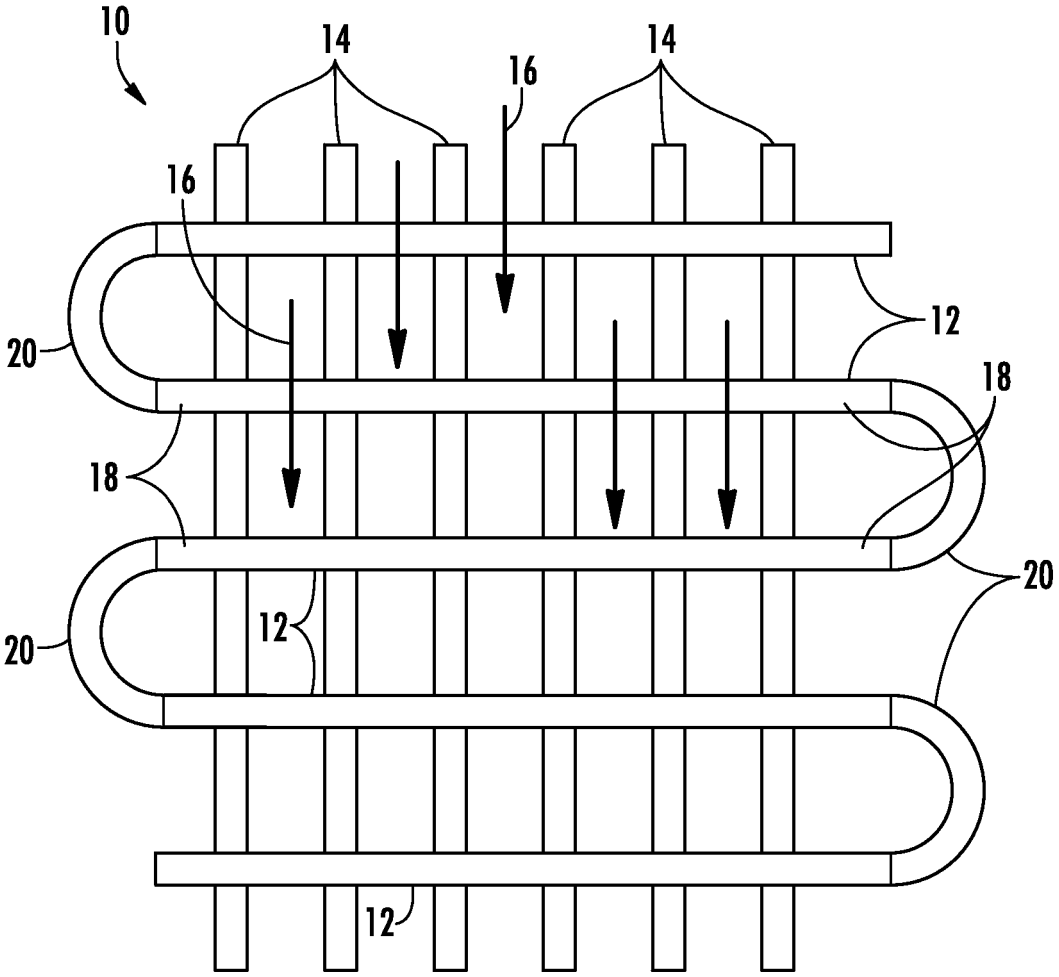


FIG. 1

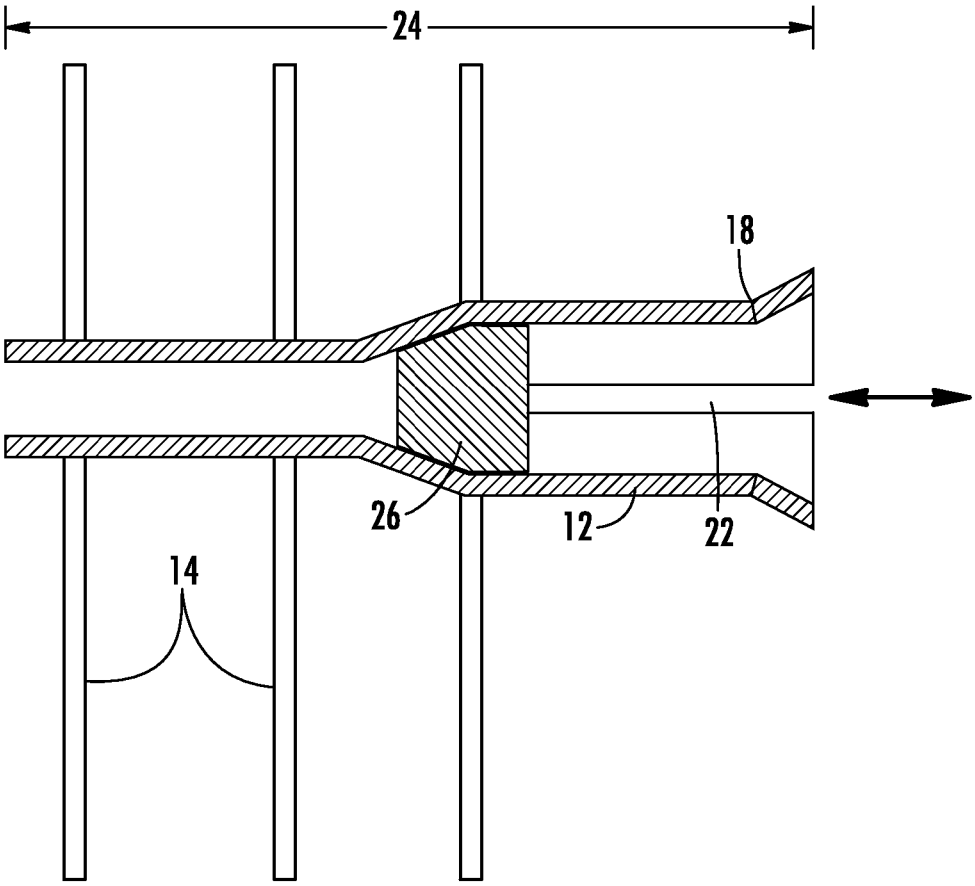


FIG. 2

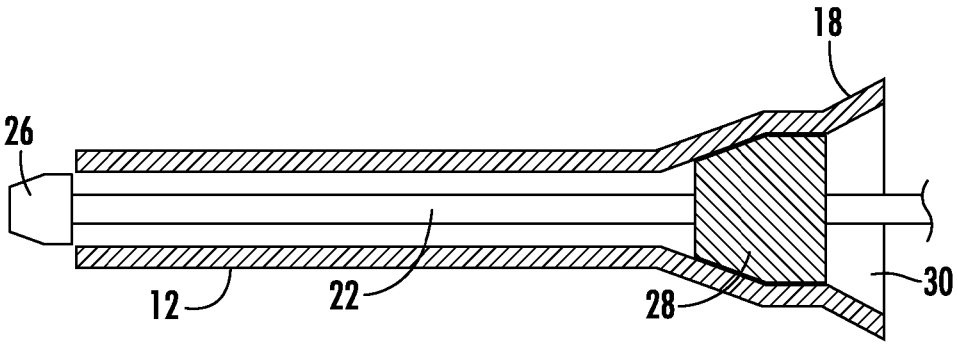


FIG. 3

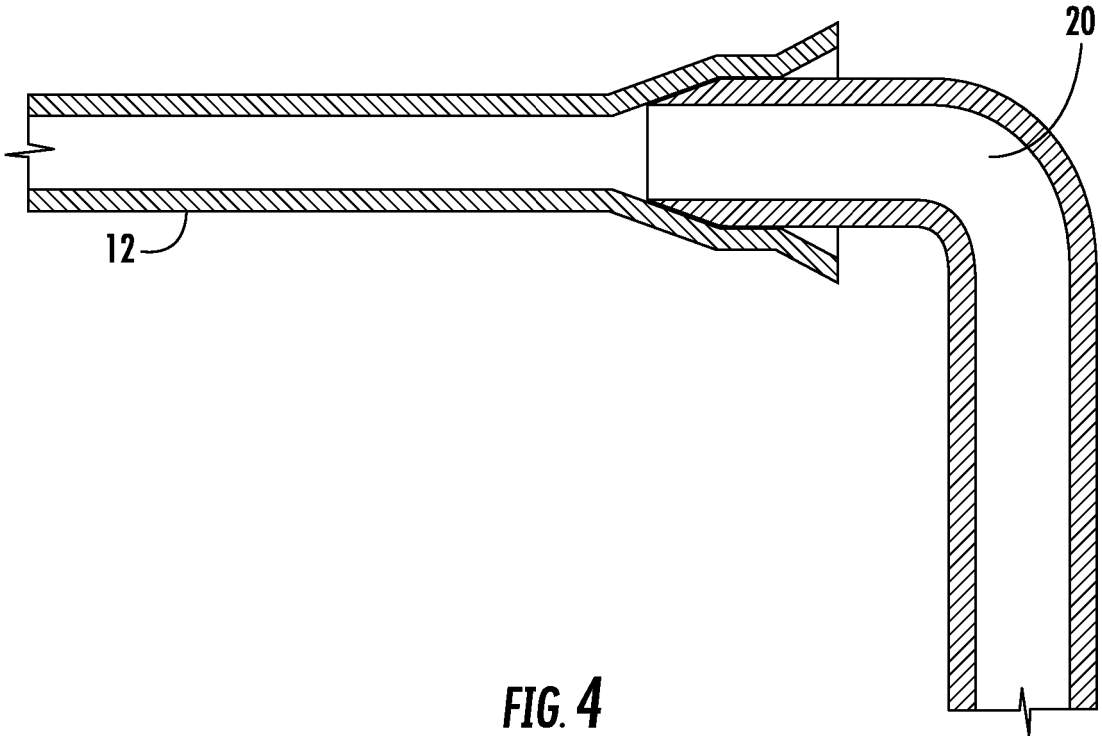


FIG. 4

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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