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(54) Title: HEAT EXCHANGER

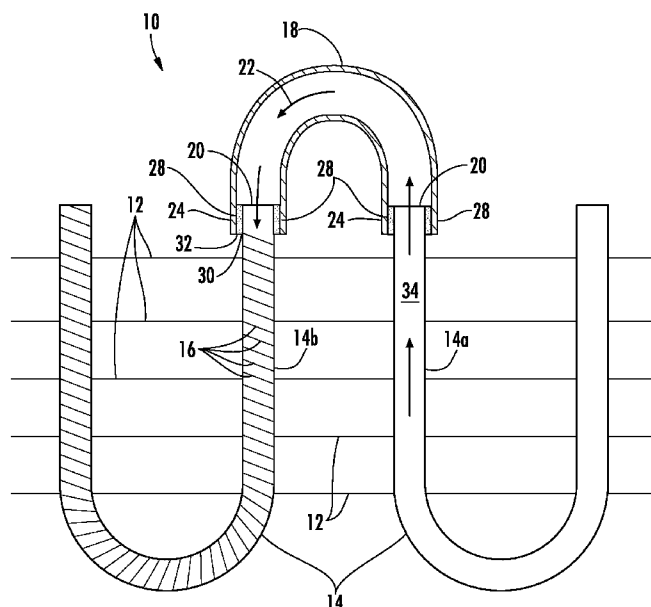


FIG. 1

(57) Abstract: A heat exchanger includes a plurality of fins and a plurality of tubes extending through the plurality of fins. The heat exchanger includes a plurality of return tubes, each return tube connected to tube ends of desired tubes of the plurality of tubes. At least one return tube of the plurality of end tubes is configured such that an inner surface of the at least one return tube is secured to an outer surface of the tube end. A method of assembling a heat exchanger includes inserting a plurality of tubes through a plurality of fins. Desired tubes of the plurality of tubes are connected via a plurality of return tubes. Each return tube connects one or more of the plurality of tubes by inserting a tube end of a tube of the plurality of tubes into a return tube end of the return tube.

**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

HEAT EXCHANGER

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates to heat exchangers. More specifically, the subject disclosure relates to construction of heat exchanger coils for tube-fin heat exchangers or the like.

[0002] Tube-fin heat exchangers are typically constructed of a plurality of hairpin tubes which pass through holes in a plurality of fins. The hairpin tubes are typically U-shaped with the open legs of the hairpin protruding through an end fin, or an end sheet of the heat exchanger. A U-shaped return tube is secured to each open leg of the hairpin to connect the hairpin to adjacent hairpins of the heat exchanger.

[0003] Before securing the return to the hairpin, the hairpin is expanded to create a mechanical joint with the fins, and each end of the hairpin is expanded into a bell shape to receive the return tube. The expansion and bellings operations require that the inside of the hairpin is lubricated, and a residue from the lubricant typically remains in the hairpin after these operations. The return is then inserted into the belled open end of the hairpin and the components are joined by an adhesive between an outer surface of the return and an inner surface of the hairpin. The presence, however, of the lubricant residue in the hairpin interferes with the bonding action of the adhesive, resulting in leaks, so the hairpin must first be thoroughly cleaned before this bonding operation, which increases cost of the heat exchanger. Further, the inner surface of the hairpin may include rifling or other surface enhancements to improve performance of the heat exchanger. The presence of these enhancements also interferes with the bonding process by presenting an uneven surface for the return tube to affix to.

BRIEF DESCRIPTION OF THE INVENTION

[0004] According to one aspect of the invention, a heat exchanger includes a plurality of fins and a plurality of tubes extending through the plurality of fins. The heat exchanger includes a plurality of return tubes, each return tube connected to tube ends of desired tubes of the plurality of tubes. At least one return tube of the plurality of end tubes is configured

such that an inner surface of the at least one return tube is secured to an outer surface of the tube end.

[0005] According to another aspect of the invention, a method of assembling a heat exchanger includes inserting a plurality of tubes through a plurality of fins. Desired tubes of the plurality of tubes are connected via a plurality of return tubes. Each return tube connects one or more of the plurality of tubes by inserting a tube end of a tube of the plurality of tubes into an return tube end of the return tube.

[0006] These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] 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:

[0008] FIG. 1 is a cross-sectional view of an embodiment of a heat exchanger; and

[0009] FIG. 2 is a cross-sectional view of another embodiment of a heat exchanger.

[0010] The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0011] Shown in FIG. 1 is an embodiment of an improved tube-fin heat exchanger 10. The heat exchanger 10 includes a plurality of fins 12, with a plurality of tubes 14 extending therethrough. The tubes 14 may be hairpin, or u-shaped, tubes as shown in FIG. 1, which extend through the fins 12 twice along their length, or may be straight tubes 14, or otherwise configured to extend through the fins 12 only once along their length. In some embodiments, an interior of the tube 14 may include enhancements, for example, grooves 16, to improve heat transfer capability of the tube 14. Though grooves 16 are shown in FIG. 1, it is to be appreciated that other forms of enhancements such as bumps, dimples, etc. are contemplated within the present scope.

[0012] A return tube 18 is secured over ends 20 of adjacent tubes 14. The return tube 18 connects a first tube 14a and a second tube 14b to allow a flow of, for example, refrigerant 22 from the first tube 14a through the return tube 18 and into the second tube 14b. In some embodiments, the return tube 18 is substantially U-shaped. Each return tube end 24 has an opening large enough to be located over the tube end 20. The return tube end 24 is secured to the tube end 20 through the utilization of an adhesive layer 28 between an outer tube surface 30 and an inner return tube surface 32. Securing the return tube 18 to the outer tube surface 30 provides better adhesion between the return tube 18 and the tube 14 since the adhesive layer 28 does not contact any lubricant residue present in an interior 34 of the tube 14 from bending or expansion operations. Improved adhesion between the return tube 18 and the tube 14 reduces leakage from the heat exchanger 10 thereby improving heat exchanger 10 performance.

[0013] Referring now to FIG. 2, in some embodiments, the return tube ends 24 may be expanded, or belled, to increase a size of the opening to allow for placement over the tube end 20. This allows for reduction in cross-sectional size of the remainder of the return tube 18, if so desired.

[0014] The tubes 14 and return tubes 18 may be formed from any desired material such as aluminum, copper, steel, stainless steel, or alloys of one or more of the foregoing, plastics or composites. Further, the adhesive layer 28 may be of an anaerobic adhesive or, for example, an epoxy adhesive.

[0015] 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 spirit and scope of the invention. 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 heat exchanger comprising:
 - a plurality of fins;
 - a plurality of tubes extending through the plurality of fins; and
 - a plurality of return tubes, each return tube connected to tube ends of desired tubes of the plurality of tubes, at least one return tube of the plurality of end tubes configured such that an inner surface of the at least one return tube is secured to an outer surface of the tube end.
2. The heat exchanger of Claim 1, wherein the at least one return tube is secured to the tube end via an adhesive layer disposed between the inner surface and the tube end.
3. The heat exchanger of Claim 2, wherein the adhesive layer comprises one of an anaerobic adhesive or an epoxy adhesive.
4. The heat exchanger of Claim 1 wherein the at least one return tube has a belled-shape at a return tube end.
5. The heat exchanger of Claim 1, wherein at least one return tube of the plurality of return tubes is substantially U-shaped.
6. The heat exchanger of Claim 1, wherein at least one tube of the plurality of tubes is substantially U-shaped.
7. The heat exchanger of Claim 1, wherein one or more of the plurality of tubes and the plurality of return tubes are formed from one of an aluminum, a copper, a steel, a stainless steel, a plastic or a composite material.
8. A method of assembling a heat exchanger comprising:
 - inserting a plurality of tubes through a plurality of fins; and
 - connecting desired tubes of the plurality of tubes via a plurality of return tubes, each return tube connecting to one or more of the plurality of tubes by inserting a tube end of a tube of the plurality of tubes into an return tube end of the return tube.

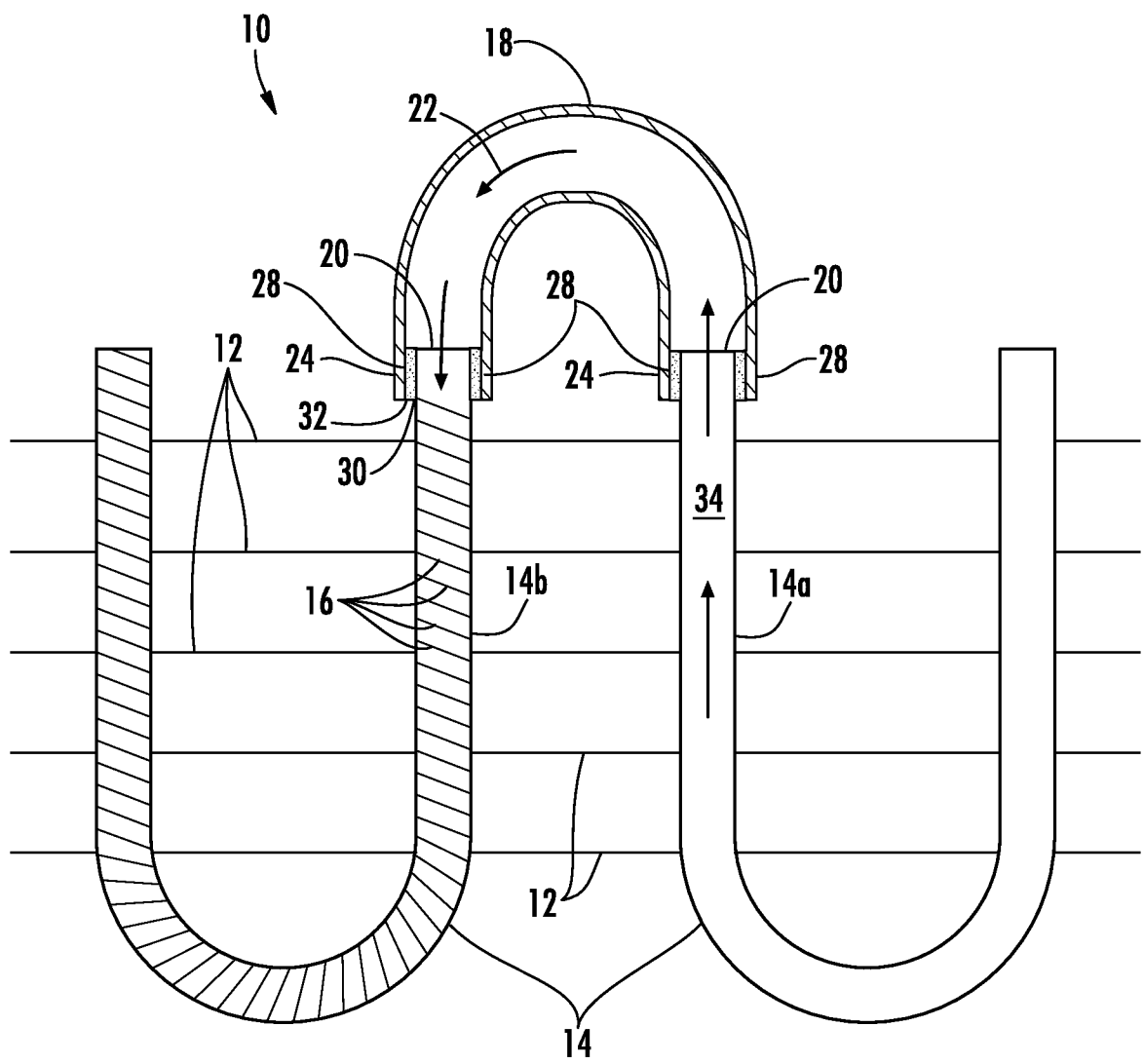
9. The method of claim 8, further comprising securing the return tube end to the tube end via an adhesive.

10. The method of Claim 9, wherein the adhesive comprises one of an anaerobic adhesive or an epoxy adhesive.

11. The method of Claim 8, further comprising expanding the return tube end before insertion of the tube end into the return tube end.

12. The method of Claim 8, wherein at least one tube of the plurality of tubes passes through the plurality of fins more than once.

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**FIG. 1**

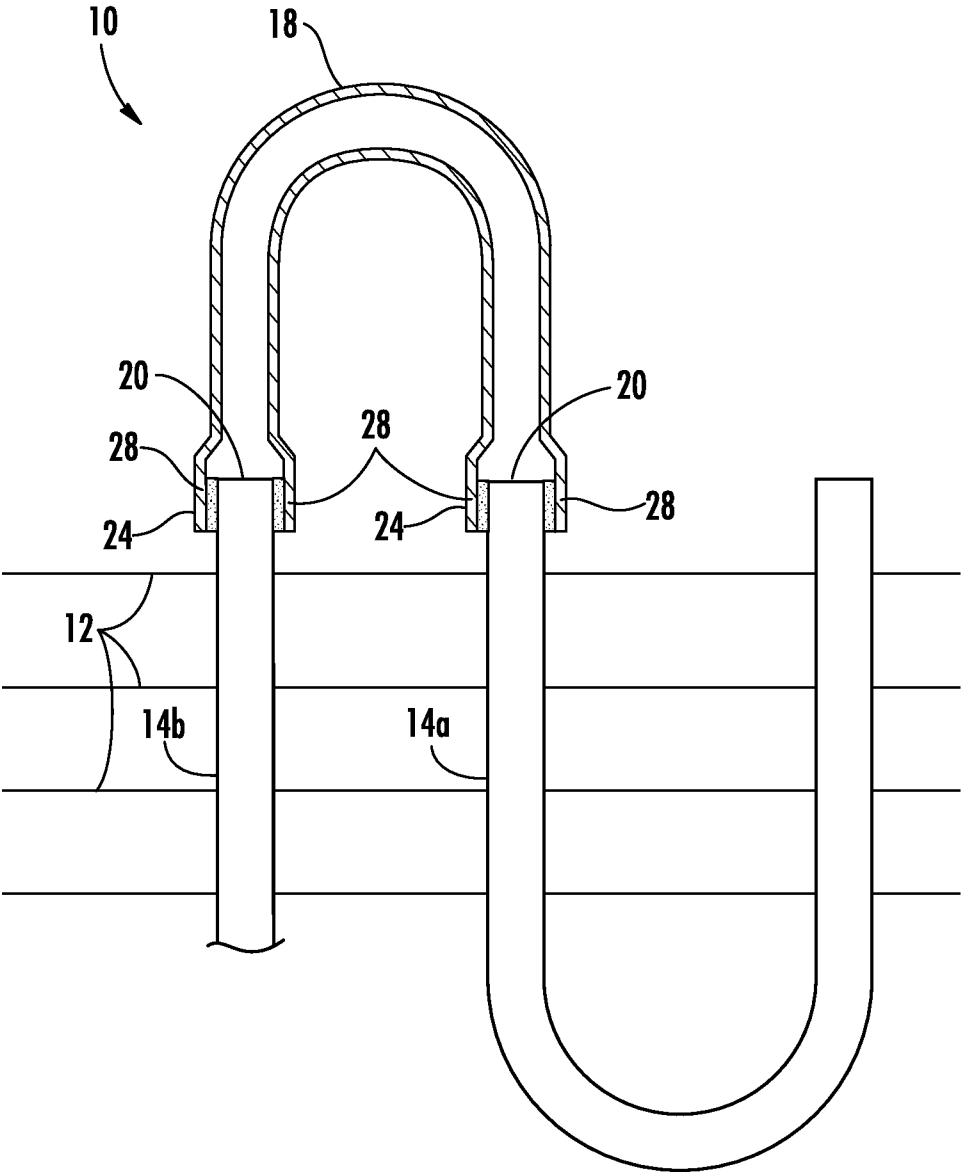


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/032985

A. CLASSIFICATION OF SUBJECT MATTER
INV. F28D1/047
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 20 2010 015200 U1 (CABERO WAERMETAUSCHER GMBH & CO KG [DE]) 17 March 2011 (2011-03-17) figure 1	1-12
X	----- US 5 211 221 A (LEASE THOMAS M [US]) 18 May 1993 (1993-05-18) figures 1,2	1-12
X	----- DE 15 25 743 A1 (MINNESOTA MINING & MFG) 13 March 1969 (1969-03-13) figures 1,2	1-12
X	----- US 3 750 248 A (MORRIS H) 7 August 1973 (1973-08-07) figure 1	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27 June 2012

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06/07/2012

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Vassoille, Bruno

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 202010015200 U1	17-03-2011	DE 202010015200 U1 WO 2012059231 A1	17-03-2011 10-05-2012
US 5211221	A	NONE	
DE 1525743	A1	NONE	
US 3750248	A	NONE	